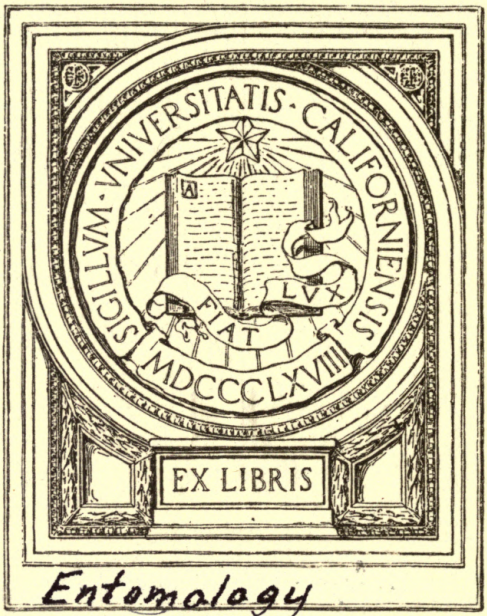
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Entomology

INSECT PESTS

OF THE

LESSER ANTILLES

By H. A. BALLOU, M.Sc.

Entomologist on the Staff of the Imperial Department of Agriculture.

Issued by the Commissioner of Agriculture.

1912.

PAMPHLET SERIES,
No. 71.

IMPERIAL DEPARTMENT OF AGRICULTURE

FOR THE WEST INDIES.

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Price 1s. 3d.

Printed by ADVOCATE CO., LTD., Bridgetown, Barbados.

PREFACE.

This Handbook, dealing with the Insect Pests of the Lesser Antilles, has been prepared by Mr. H. A. Ballou, M.Sc., Entomologist on the Staff of the Imperial Department of Agriculture, with the object, as is stated by the Author, of giving in plain and simple language, 'a brief general account of our present knowledge of some of the principal insect and mite pests of the crops grown in the Lesser Antilles; also of the pests attacking man and domestic animals, as well as of those of the household.' As is stated further, the scope of the work does not admit of the presentation of detailed accounts of insects, nor of descriptions of all insect enemies of plants in the West Indies. An attempt at such a presentation would actually have defeated its object, as this is outlined above; whereas on the contrary, a perusal of the work as it stands is sufficient to show that this object has been fully and usefully attained.

The arrangement of the subject-matter is such as to make reference easy, and to bring forward the information in such a way that each subject falls into its natural place in the sequence. The large extent to which illustrations have been employed will add greatly to the usefulness of the work, particularly in so far as it is employed by practical agriculturists. Its educational character will doubtless be found of value in connexion with nature teaching and lessons in agriculture in schools; in the hands of the teacher, it will assist in presenting and formulating the information to be given, and will aid in providing and identifying the specimens that are required indispensably for demonstration.

The Handbook presents, to a great extent, a carefully prepared summary of information contained in a large number of entomological publications of different kinds, and

this fact is sufficient in itself to make it particularly useful to agriculturists, as well as to others by whom it will doubtless be consulted, who do not possess the time or the facilities for reference to entomological subjects that are of importance to them. My thanks are due to Mr. Ballou, for the careful way in which the work has been compiled, and it is due to him, also, to place the fact on record that the book derives an additional value, which will be recognized to an increasing extent as it comes into general use, from the circumstance that it presents information that is the outcome of his special work and observation in the West Indies—information that in many cases relates to forms of insect life, both injurious and beneficial, that were not known previously to be of economic importance.

Francis Watts.

Commissioner of Agriculture
for the West Indies.

Entomologist,
To the Imperial Commissioner of Agriculture.

Sir,

I have the honour to submit, herewith, a manuscript with illustrations, which I have prepared for publication as a Handbook of Insect Pests of the Lesser Antilles. This might be included in the Pamphlet Series of the publications of this Department.

2. The object of this book is to present, in plain and simple language, a brief general account of our present knowledge of some of the principal insect and mite pests of the crops grown in the Lesser Antilles; also of the pests attacking man and domestic animals, as well as of those of the household.

3. It would not be possible, within the scope of a small work, to include an account of all the insects which are known to attack plants in the West Indies, nor to give detailed accounts even of the more important ones without greatly exceeding the limits of such a volume as this.

4. I can make no claim for originality in connexion with the information presented herewith, although much of what is here given has already appeared in articles prepared by me for publication in the *Agricultural News*, the *West Indian Bulletin* and the *Pamphlet Series;* and in so far as these articles have referred to work done by me under the direction of the Imperial Commissioner of Agriculture, they were records of original work. This last is especially true of certain pests which have appeared in these islands during the past nine years, as new pests unknown in other localities.

5. The recorded knowledge of many of the forms of insect life which are of common occurrence in many parts of the world, is distributed throughout entomological publications, such as text-books and the publications of Departments of Agriculture and of Experiment Stations. A considerable amount of such general knowledge has, of course, been utilized in the preparation of this work, a certain amount of it having been verified by observation and experiment.

6. Since this book is entirely popular and the information has appeared previously in the publications already mentioned, I have made no attempt to quote references to authorities.

7. Planters and others who use this book are almost certain to find many points where the information given fails to apply exactly to the local conditions. If these differences could be reported and recorded, the added information thereby acquired would be extremely useful in preparing a revision, if that should become desirable.

8. The blocks from which the illustrations are produced are all in the possession of this Department, having been acquired during the past twelve years from several sources, which are indicated on another page, where acknowledgments are made. The source from which the blocks have been obtained is stated also in connexion with the legend which is given with each figure.

9. The Rev. N.B. Watson, F.E.S., has been kind enough to read the proof critically; for this I desire to express my thanks.

I have the honour to be,
Sir,
Your most obedient servant,

(Sgd.)
H. A. BALLOU,

Entomologist.

ILLUSTRATIONS.

The illustrations which appear in the following pages are 185 in number. They are produced from blocks in the possession of this Department which have been obtained from the sources indicated below.

Through the courtesy of the United States Department of Agriculture it has been possible to obtain duplicates of electrotype blocks which have been used previously to illustrate the publications of that Department.

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Figures 45 and 47 are from blocks procured through the courtesy of the Secretary of the New York Entomological Society.

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The half-tone block for figure 185 was prepared from a photograph forwarded by the Superintendent of Agriculture, Grenada.

All other half-tone blocks are from photographs taken by the writer. These are all acknowledged as 'original' in the legends, even though some of them have previously appeared in the publications of this Department. Those which have already been published are shown at figures 25, 42, 43, 44, 65, 70, 91, 108, 121, 122, 123, 124, 125 and 169.

The half-tone blocks which now appear for the first time are shown at figures 2, 3, 6, 7, 15, 20, 23, 26, 27, 32, 33, 38, 46, 55, 56, 71, 72, 80, 84, 89, 98, 112, 129, 134, 155, and 178.

CONTENTS.

CHAPTER I.

Introduction.

In 1901, the Imperial Department of Agriculture issued Pamphlet No. 5, entitled General Treatment of Insect Pests. At that time, the Department had recently begun to deal with the problems presented through the attacks of insects on crops, and consequently the information then published was of the most general character. The ten years which have since elapsed have brought about a much wider knowledge of the insects which occur in these islands.

It may be well to remind readers of this book that the Imperial Department of Agriculture has been in direct relationship with the agriculture of the British islands of the Leeward and Windward Colonies, and Barbados, and that references to the Lesser Antilles will be understood to apply to these Colonies only.

The crops grown in the West Indies are much the same as they were ten years ago, the principal difference being in the standing of the cotton industry, which was then entering upon an experimental trial. It need not be stated here what measure of success attended these trials, nor the rapidity with which a profitable industry was established. As a result of the rapid increase in the acreage of cotton, insects which previously were not recognized as pests, and in some cases even were not known to science, have assumed an important position as serious pests.

Further study of the conditions in regard to the cultivation of other crops has also led to the recognition, as pests, of insects which formerly were entirely ignored.

In the following pages an attempt is made to present a general account, in popular language, of insects and their allies (mites and ticks) which are of importance. These are arranged in groups according to the plants or animals which they attack, and in many instances information is given as to their natural enemies.

In addition to the remedies and control measures which are suggested in connexion with the account of each pest

the chapter on the control of insects gives information in regard to many insecticide substances with directions for making various mixtures.

The use of insecticides is explained, and descriptions are given of the machinery and appliances adapted to their application.

The insects which attack growing crops may be grouped in three main divisions, according to their manner of feeding, or their habit of living. These are leaf-eating, sucking, and boring.

Leaf-eating insects are represented by a great variety of caterpillars, beetles and grasshoppers, which with their powerful mouth parts are able to bite off particles of the plant, which they chew and swallow. Sucking insects are those which have their mouth parts developed in such a manner that they are able to puncture the tissues and suck out the juices of the plant. They are represented by scale insects, plant lice, white fly, cotton stainers, and bugs of several kinds. Under this heading, also, might be included thrips, red spider, leaf-blister mite, red maggot and flower-bud maggot. The first two of these, thrips and red spider, are intermediate in their feeding habits between the biting and sucking types of insect, their mouth parts being adapted to enable them to gnaw away the surface of the tissue where they feed; after this they obtain their food, probably by a process of lapping, from the freshly exposed tissues. The leaf-blister mite probably feeds in much the same way, concealed among the plant hairs within the blister or gall which is produced on the plant by the irritation due to its activities. The flower-bud maggot and red maggot live in nutritive tissue, and may absorb a certain amount through the skin.

Boring insects are those which tunnel out for themselves galleries within the tissues of plants. Their attacks are made on the stem, the root, and the fruit of various plants. The boring is generally done by such insects when they are in the larval stage. Examples of this group of insects are to be found in the moth borer and weevil borer of the sugar-cane, the lime tree bark borer, the cacao borer, the palm weevil and others which bore into the stems of plants; the root borer of sugar-cane, the scarabee of sweet potatoes and others which bore into the roots. The minute larvae of certain flies and moths live as miners in the leaves of plants, forming galleries just beneath the epidermis. The mole

cricket might also be mentioned in this connexion, on account of its underground habit of life and its manner of attacking the roots of plants, although it does not actually bore into the tissues, after the typical manner of borers.

Insects which bore into the fruit are represented by the cotton boll worm, corn ear worm and the larvae or maggots of fruit flies.

Insects which are injurious to stored products are the meal worms, grain weevils and the cigarette beetle. Among those which are known as household pests may be mentioned cockroaches, crickets, ants, bed-bugs, clothes moths, cigarette beetles, silver-fish and house-flies.

The insects which attack and injure domestic animals and man have come, within the last few years, to be recognized as of great importance, many of them being known to disseminate some of the most serious of diseases, and others being suspected as having a possible influence in the same direction. Among these may be mentioned fleas, flies, ticks, lice, the mites which cause itch, mange and scab, the screw worm, mosquitoes, chigoes or jiggers, bête-rouge and the bed-bug.

In order that readers of this booklet may be better able to understand the insects with which they may have to deal, a short account follows of the group of animals which includes insects and their nearest relations, and of the natural history of insects. A brief account of the orders of insects gives the characters of each Order in such manner that, in general, there should be no difficulty in placing the greater number of insects in their correct Order; and to aid further in this, a key is included, with directions for its use.

CHAPTER II.

Insects and their Near Relations.

The animal kingdom is divided into several great groups, or sub-kingdoms, in each of which the members have some points in common.

One of these groups has been given the name Arthropoda, which means 'jointed feet', or perhaps, better, 'jointed limbs.'

The arthropods are all alike in having jointed limbs, and bodies that are jointed, or at least that are easily separable into regions or sections, such as head, thorax (the middle body) and abdomen; or head and hind body; or cephalothorax (head and thorax fused together), and abdomen. Arthropods have an exoskeleton of a hard, firm substance, called chitin, to which muscles are attached on the inside; this protects all the soft and delicate organs

The arthropods in their turn are divided into four classes as follows:—

Class I. Crustacea—Crabs, Lobsters, Wood-lice etc.
„ II. Arachnida—Spiders, Mites, Scorpions, etc.
„ III. Myriapoda—Centipedes, Millepedes, etc.
„ IV. Hexapoda—Insects.

Among the Crustacea are to be included crabs, lobsters, shrimps, barnacles, etc., many of which are familiar objects in most parts of the West Indies. Fig. 1 represents a wood-louse, or sow-bug, one of the crustaceans. The crustaceans are mostly aquatic; a few live in damp situations such as damp soil or decaying vegetable matter. They breathe by means of gills, the head is provided with two pairs of antennae, the abdomen has appendages which are used in locomotion and the eyes are usually compound, sometimes stalked. The body generally is divided into two regions, the cephalothorax and the abdomen. The cephalothorax is composed of the head and the thorax fused together, and is often protected by a hard shell, the carapace. The

exoskeleton of chitin is often impregnated with large quantities of lime.

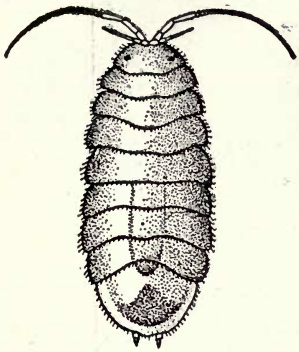

Fig. 1. Crustacean. A Wood-louse. *Enlarged.* (*From U. S. Dept. Agric.*)

The Class Arachnida includes the spiders, mites, ticks and scorpions. These animals breathe by means of air-tubes (tracheae), or air-sacs. Certain species, mites especially, have the entire surface of the body adapted for respiration. In the case of most members of this group, the head and thorax are fused to form a cephalothorax, and the eyes are simple.

The scorpions (Fig. 2) are well known in tropical countries, on account of the painful sting they are able to inflict. They are mostly predaceous and nocturnal in habit, living in damp situations.

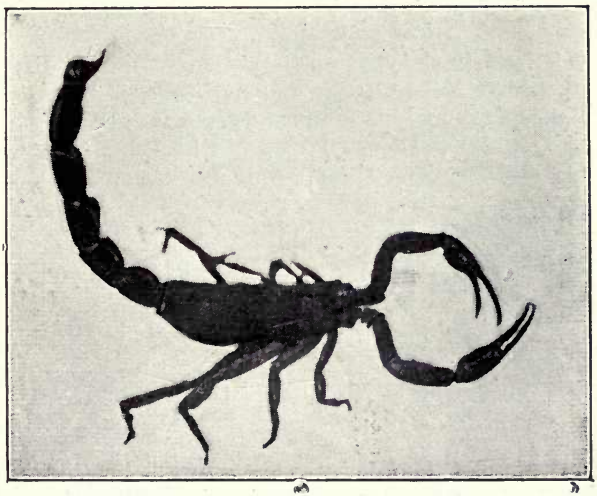

Fig. 2. Arachnid. A scorpion. *Slightly reduced.* (*Original.*)

The whip scorpions (Fig. 3) receive their name from the long lash-like development of the first pair of legs. In the illustration these are the slender appendages which are

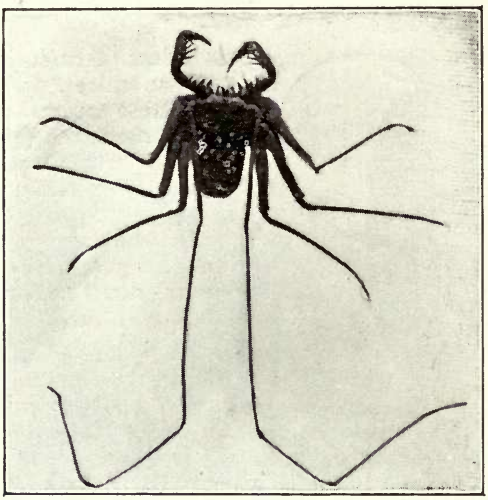

Fig. 3. Arachnid. A tailless whip scorpion.
About natural size. (Original.)

shown turned to the rear on the back of the animal. They are not known to be injurious or destructive.

The spiders include many species of varying size and form. The four pairs of long legs furnish the most prominent character of this group.

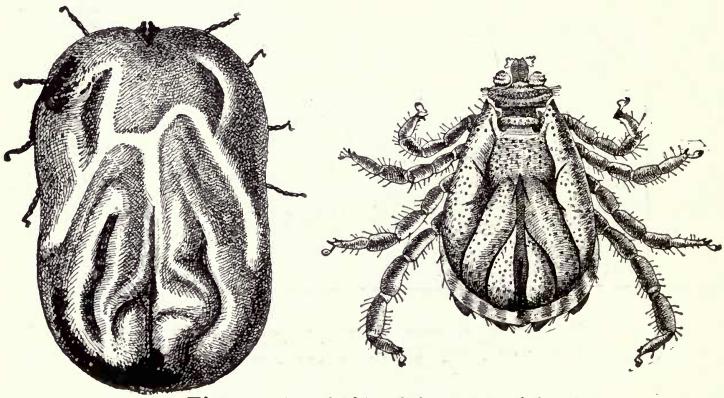

Fig. 4. Arachnid. The cattle tick.
Female cattle tick at the left, male at the right. Enlarged.
(From U. S. Dept. Agric.)

The ticks are parasitic on many forms of animals. The common cattle tick (Fig. 4) occurs on domestic cattle, while similar forms attack dogs, goats and fowls. They often transmit diseases, and on this account, in addition to being parasites they are the cause of serious loss.

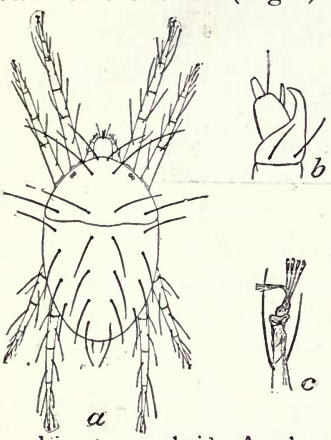

Fig. 5. Arachnid. A red spider.

(a) *adult ;* (b) *palpus ;* (c) *claw. Enlarged.* (*From U. S. Dept. Agric.*)

The red spider (Fig. 5) is a good example of the mites which attack plants, feeding on leaves, fruits and bulbs.

The Myriapoda, Class III, include the centipedes and the millipedes (Figs. 6 and 7.) These are elongate animals with segmented bodies and jointed limbs and appendages.

The head is distinct from the rest of the body, but the thorax and the abdomen do not differ in structure. The hind body is generally provided with legs throughout its entire length, one or two pairs to each segment.

The Centipedes (Fig. 6) are predaceous in habit. They are also venomous, and by means of the strong fangs formed by

Fig. 6. Myriapod. A Centipede.
Reduced. (*Original.*)

the modified first pair of legs are able to inflict painful and sometimes dangerous wounds.

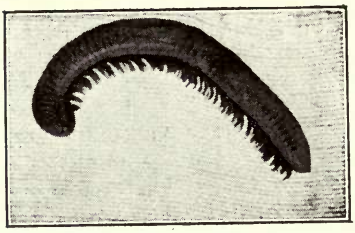

Fig. 7 Myriapod. Millipede.
Reduced. (*Original.*)

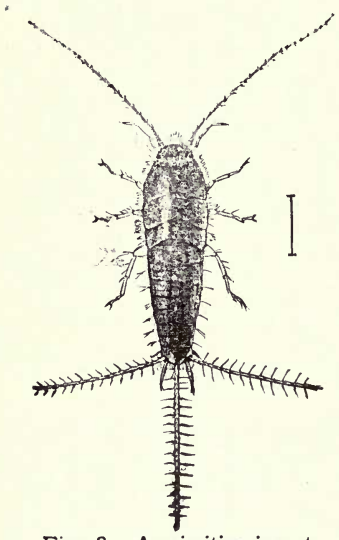

Fig. 8. A primitive insect. The silver-fish.
Adult. Enlarged. (*From U. S. Dept. Agric.*)

The Millipedes (Fig. 7) are mostly scavengers, feeding on decaying vegetable matter, though sometimes they attack growing plants. They are not often pests, however.

Class IV is the Hexapoda, or true insects. The name Hexapoda means having six legs, and this expresses one of the most distinguishing characters of the insect. In addition to being arthropods having six legs, insects are to be distinguished from others of the group by the following features. The insect body is readily separable into three definite regions—head, thorax and abdomen, and the adult is usually winged. The normal number of wings is two pairs, but it sometimes happens that one, or even both, pairs of wings is wanting, as in the silver-fish (Fig. 8).

CHAPTER III.

Natural History of Insects.

Structure and Growth.

As has been stated already, insects are animals which, in the adult condition, have never more than six legs, and generally, two pairs of wings (which may be wanting but are never more in number), and a body made up of three

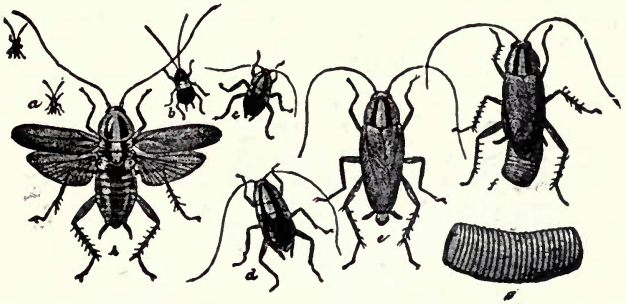

Fig. 9. Insect with incomplete metamorphosis. A cockroach. (*a*) (*b*) (*c*) (*d*) *immature stages*; (*e*) *adult*; (*f*) *adult with egg case*; (*h*) *adult with wings spread*; (*g*) *egg case. All natural size except* (*g*) *which is enlarged.* (*From U. S. Dept. Agric.*)

distinct parts—head, thorax and abdomen. The legs are attached to the thorax, one pair to each segment; the fore and hind wings are attached to the second and third segments, respectively. The head and abdomen have no organs of locomotion. To the head are attached the mouth parts, and the antennae, which are sensory organs. The abdomen also sometimes has sensory organs. Fig. 9 shows the cockroach and the attachments of wings and legs.

In the case of most insects, the adult deposits eggs from which the young are hatched. There are instances, however, among these animals, in which the young are already hatched from the egg at the time when they are born. That is to say, they are active and free-moving, having accomplished one stage of their existence within the body of the parent.

After the birth of an insect, or the hatching from the egg, it goes through changes and developments before reaching the fully developed or adult condition. This change and development is called the metamorphosis. Metamorphosis may be either complete or incomplete. This does not mean that development stops short of the perfect insect, in the case of insects which have incomplete metamorphosis, but rather expresses a general difference between these two kinds of development.

Insects which have an incomplete metamorphosis are something like the adult when they are first hatched from the egg. (Fig. 9, young and adult cockroaches.) They are, of course, much smaller, and without wings, but in general form they give an idea of what they will be like when they are full-grown. Insects which have a complete meta-

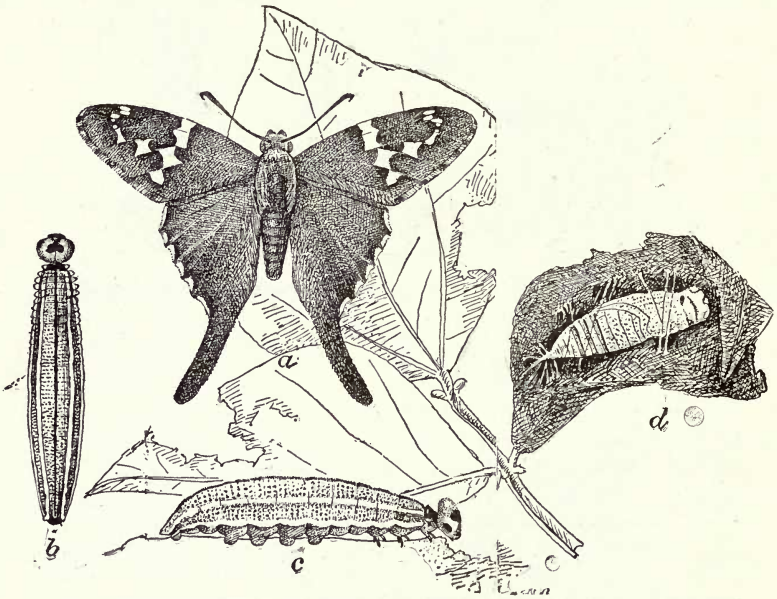

Fig. 10. Insect with complete metamorphosis. The bean leaf-roller.
(*a*) *butterfly*; (*b*) *larva, dorsal view*; (*c*) *larva, lateral view*; (*d*) *pupa in rolled-up leaf. Somewhat enlarged.* (*From U. S. Dept. Agric.*)

morphosis are very different, when first hatched, from the adult form into which they finally develop. Such insects have four distinct stages, or periods in their

lives. These are, the egg, the larva, the pupa and the giamo. The egg is the first stage in the development of a generation, and the larva is the next. The larvae of the butterflies and moths are called caterpillars; of beetles, bees and wasps, grubs; and of flies, maggots. This is the portion of an insect's life when all growth in size takes place. The pupa is the state during which the change takes place, in which the larva is transformed into the final and adult condition of the insect's life; the wings are formed and the reproductive organs become complete. The pupa of a butterfly is called a chrysalis; that of a moth is often enclosed in a cocoon. Fig. 10 shows the bean leaf-roller (*Eudamus proteus*) with larva (*b* and *c*), pupa (*d*), and adult (*a*). In the case of insects which have an incomplete metamorphosis, there is not the same distinction between the larva and pupa, as in the case of those in which this is complete. There is no quiescent stage during which the insect transforms, as in the case of the chrysalis of the butterfly. (See Fig. 9.)

The growth of insects is accompanied by a series of moults. The chitinous exoskeleton, once formed and hardened, is not capable of growth, and it is natural that it should be shed at intervals, when the limbs and organs have increased in size as much as they can. Before the old skin is cast off, there is formed under it another, which is soft, pliant and elastic. As soon as the old one is shed, the new skin is stretched out by the pressure from within, and it then hardens. The exoskeleton, as it now becomes, is fixed, and does not grow any more. The size of the insect is stationary until the next moult, except that the flexible connective tissues between the segments are capable of stretching a little.

The body of a caterpillar, which may be considered a typical insect in the larval condition, is composed of thirteen segments, as follows: the head, which appears as one; the thorax, three; and the abdomen, nine. The segments of the thorax and abdomen are chitinous rings, joined together by means of a flexible connective tissue, which allows for great freedom of movement, and, as already stated, for a certain amount of growth in size. In most adult insects, it is not easy to distinguish the segments which go to make up the thorax and abdomen, because these are often much modified in accordance with the habits or structure of the insect.

The growth of insects always takes place during the larval portion of the life-cycle. Caterpillars, for instance, moult, or shed their skin, four or five times during their growth, from hatching to pupation. Adult insects do not grow in size. Once the wings have been developed, the insect is full-grown. Small flies do not grow into big flies, small moths do not grow into large ones, nor small beetles into large beetles.

It should be remembered that butterflies and moths, beetles, flies, bees and wasps all develop from a larval stage which is very different in appearance from the adult form, and that the change in appearance is brought about in the period of pupation. On the other hand, such insects as grasshoppers, cockroaches and cotton stainers, which have an incomplete metamorphosis, are in the immature stages somewhat like the adult in general form, but without wings or with developing wings. In the case of any insect, however, the winged individual is the adult.

Senses.

Insects have well developed senses of taste, smell, hearing and sight. They have also well organized digestive, nervous, circulatory, and respiratory systems.

It is next to impossible to determine exactly the functions of certain sense organs in insects. The organs for seeing, hearing and for producing sound can be recognized by their structures,and by experiment, but there are others, the function of which it is not so easy to determine.

The sense of taste is probably located in the small appendages of the mouth parts, the senses of smell and hearing are, in some insects at least, in the antennae, which are often the most conspicuous appendages of the head. Special organs of hearing are sometimes (in certain Orthoptera) to be found on the abdomen and legs. The sense of sight depends on the eyes, which are of two kinds, simple and compound. The compound eyes are often made up of many facets and are located at the sides of the head, while the simple eyes, or ocelli, are situated between them, either on the top or the front of the head.

The simple eyes of insects are not always present, but when they occur, they are two or three in number. The compound eye is perhaps the most complex and delicate structure in the insect world.

In many instances, the compound eyes occupy by far the greater part of the entire surface of the head, and the number of elements or facets which go to make up one of these compound eyes often runs to many thousands, although sometimes it is small.

It is not likely that insects have power of vision over long range, or that they see distinctly. They are all conscious of light and darkness, and some of them distinguish certain colours; many of them discriminate moving bodies, and others perhaps, recognize at greater or less distances those insects on which they prey, or insects or birds to which they are likely to fall a prey.

Circulation.

The arrangement of the circulatory, digestive and nervous systems in insects is a typical characteristic. The alimentary canal is central in position; the organ of circulation is dorsal, and on account of its position, has received the name of dorsal vessel; the nervous system is ventral. The accompanying diagram (Fig. 11) represents a median longitudinal section through the body of a caterpillar. The dorsal vessel, the digestive system and the nervous system are shown in their relative positions, and are referred to by letters in the legend lines. The blood of insects is not confined in veins, arteries and capillaries, as is the case in the

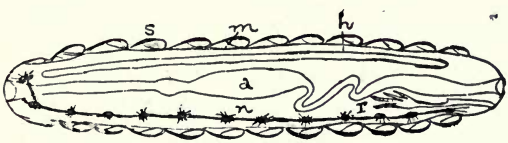

Fig. 11. Diagrammatic vertical section lengthwise through body of insect to illustrate relative positions of some of the more important organs.

(s), segments of body wall; (m), muscle layer; (h) heart or dorsal vessel; (a), alimentary canal; (n), nervous system; (r), reproductive organs. (Redrawn from Comstock's Manual for the Study of Insects.)

higher animals; it fills the body-cavity and bathes all the organs, even penetrating into the legs and wings. It is usually colourless, but is sometimes tinted yellowish, green, and even red, but does not derive its red colour from red corpuscles, and is not red blood in the same way as is the blood of the higher animals.

The organ of circulation is the heart or dorsal vessel. As has been said, it is called the dorsal vessel because of its position in the body, lying as it does along the median line of the back, just under the body wall. The heart is a straight, unbranched, tubular organ provided with muscles, extending from the hinder end of the body to the head; it is generally closed at the posterior end and open anteriorly. The portion lying within the abdomen is constricted at intervals, and at each constriction there is a valve. These valves divide the dorsal vessel into compartments or chambers. By means of a rhythmic contraction and expansion of the walls of the dorsal vessel, accompanied by a regular opening and closing of the valves, the blood is forced from the rear toward the head, to the long aorta-like portion of the dorsal vessel lying within the thorax. The chambers are provided with small openings which communicate directly with the body-cavity, and through which the blood in the body-cavity is taken into the heart and put into circulation.

The pulsations of the dorsal vessel and the movement of the blood in the body-cavity can easily be observed in certain caterpillars. The arrowroot worm, or canna leaf-roller (*Calpodes ethlius*), is the best of our common West Indian insects for the purpose.

Respiration.

Insects breathe by means of air-tubes (tracheae) which begin at openings in the body wall, and extend throughout all parts of the insect structure. The apertures, which are called spiracles, or stigmata, are valvular, and are capable of being opened and closed. On the outside, they are also generally protected by hairs. There are usually ten stigmata on each side of the insect body; but there are sometimes less, and they also vary in their position, according to the life-habits of the insect. They may be distinctly seen with the naked eye in many insects. In certain large caterpillars, they are surrounded by fine lines, or are enclosed in spots of colour, which make them prominent. In the grasshopper, they may be easily seen—two on the sides of the thorax, and eight on the abdomen. The tracheae are composed of chitin, and are continuous with the body wall. The smaller air-tubes are simple tubular structures, but the larger are strengthened on the inside by ridges, arranged spirally.

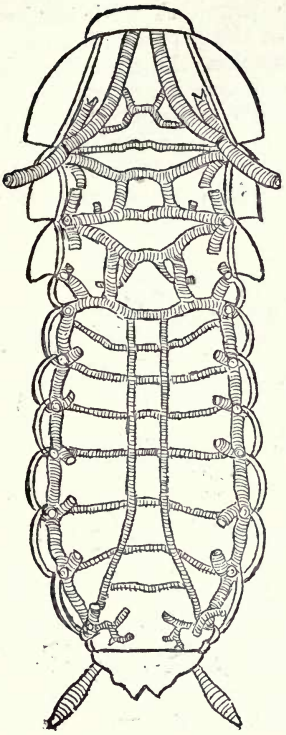

Fig. 12. Tracheal system of cockroach.
(*Redrawn after Miall & Denny.*)

The tracheae from the stigmata connect with main lines, which extend the length of the body; from these the branches and smaller tubes communicate with all parts. In Fig. 12, the cross-shaded portions are the tracheae, the very fine cross lines representing the thickenings mentioned above.

In large insects which fly long distances, such as pond-flies, butterflies and moths, some beetles, flies, bees, etc., there often occur large distensions of certain tracheae to form air sacs, which are probably of use to the insect in making the body more buoyant, and in increasing the rapidity of breathing.

Insects are air-breathers, with few exceptions; most of those which live in the water must come to the surface from time to time for a supply of air, and in many cases the habit of living in water, in decaying organic matter, in plant tissues, or as animal parasites, necessitates some modification, or special adaptation, in the manner of obtaining the necessary air.

Mosquito larvae (Fig. 13) breathe by means of a special organ at the posterior end of the body, which is brought into contact with the air. Maggots of flies which live in plant or animal tissues often have spiracles at that end of the body, which communicate with the air. In the accompanying illustration (Fig. 13) the tracheal tube, at the posterior end of the body, is shown at right angles to the body. The main tracheal trunks are indicated by the faint lines which may be traced through the segmented abdomen into the broad thorax, where they diverge.

Water beetles come to the surface and carry down, when they dive again, a film of air held by the fine hairs of

the body, while certain insects are provided with tracheal gills, in the aquatic larval stage. In the case of the larva of the pond-fly and of a few other species, the modifications of the tracheal system adapt the insect to a completely aquatic existence over a certain portion of its life-cycle. In these instances, which are the exceptions rather than the rule, the insect derives oxygen from the water in a manner exactly similar to that employed by fishes, which breathe by gills.

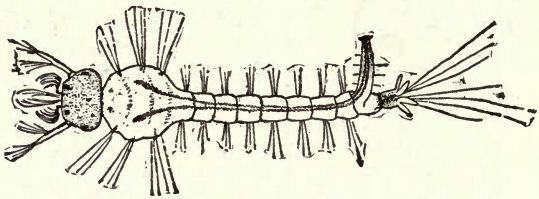

Fig. 13. Larva of mosquito.
(*From U. S Dept. Agric.*)

The aeration of the blood is accomplished in a manner exactly opposite to that in higher animals. The air penetrates to all parts of the body by means of the tracheae, which are bathed by the blood, and comes into intimate contact with the food-substance by means of the minute branches of the tracheae which envelop the alimentary canal.

Nervous System.

The relative positions of the vital systems are also opposite in insects to those in higher animals. In insects the circulatory system is dorsal, and the nervous system is

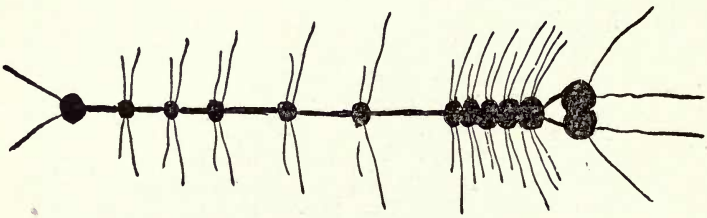

Fig. 14. Nervous system of an insect.
(*Redrawn from Theobald, Agricultural Zoology.*)

ventral, while in vertebrate animals the nervous system is dorsal and the circulatory one ventral.

In insects, the nervous system is not concentrated into a large brain, but is divided among a series of nerve centres, or ganglia, arranged in pairs often fused together. The ventral line in Fig. 11 shows the position of these ganglia and their connecting nerve cords, and Fig. 14 shows the ventral nervous system, with its small nerve-branches.

The double mass shown at the extreme end, and the next portion connected by the heavy lines, together form the brain. The former portion is above the oesophagus, or gullet, and the latter below, and the heavy lines referred to are nerve cords which connect the two parts, the gullet running through the opening thus made. The first portion of the nervous system is the supra-oesophageal ganglia, the second the sub-oesophageal ganglia ; these are connected by the oesophageal nerve collar. Next follow three thoracic and seven abdominal ganglia, all connected by a central nerve cord.

The nervous system varies according to general structure, usually by fusion of ganglia ; but, with the exception of the supra-oesophageal ganglia, it is always ventral in position. Nerves extend to all the organs and muscles, and permit the insect to respond to a stimulus of any sort.

The nerve-endings in certain insect structures, such as antennae, palpi, etc., are very delicate, and enable the insect to be conscious of very slight stimuli.

Digestion.

The digestive system in insects, in its simplest form, consitss of a cylindrical tube, extending in a direct course from the mouth to the anus. In the more specialized insects, the alimentary canal is very modified, being folded and doubled on itself in such a way as to give it a length considerably in excess of the total length of the body. The organs which are concerned with feeding and digestion occupy a very large proportionate part of the entire body-cavity, as may be seen by reference to the drawing at Fig. 11. Food taken in at the mouth passes by means of the oesophagus, or gullet, to the stomach. Sometimes a crop and gizzard are developed—the crop for storing a portion of food, the gizzard with strong muscles and

chitinous ridges and hooks, by means of which the food is reduced to a finer condition before entering the stomach. In certain insects, at least, a larger part of the actual digestive process is carried on in the crop, and in these also, the gizzard serves as a strainer through which the finer portions of the food, with digestive fluids, are carried to the stomach, in which absorption takes place. The stomach is a large digestive organ (Fig. 11) from which the food passes to the intestine, colon, rectum, and to the anus, where waste and undigested food is voided. The food canal is composed of three sections, the fore-gut, mid-gut and hind-gut.

The manner of taking food also varies greatly among insects. Certain insects with biting mouth parts, such as grasshoppers and many beetles, eat vegetable food, in both the larval and adult stages of their development. Others, such as plant lice and cotton stainers, take plant food by means of sucking mouth parts also during the whole of the larval and adult life. Others, still, feed with biting mouth parts in the larval stage, and in the adult one either do not feed at all, or get their food by sucking the juices of plants and flowers. Many butterflies and moths are examples of these. Other examples of the variety of ways of feeding are to be seen in the mosquito, the larva of which is a scavenger or predator in stagnant water, while the adult male sucks the juice of fruits and flowers, and the adult female the blood of animals. Another example is to be found in many bees and wasps, where the same individual possesses mouth parts developed for both biting and sucking.

The manner of feeding has a great influence on the development of the food canal. Larvae, with biting mouth parts, which feed on vegetable matter have very large alimentary systems, while predaceous insects have smaller ones, and those which suck the juices of flowers and plants, and the blood of animals, smaller still. Certain insects which suck their food, such as Lepidoptera, Diptera and Hemiptera, have a development of the gullet which acts as a sucking-pump, by means of which the food is taken up and forced back into the stomach. In bees and ants, the region of the gizzard is occupied by the honey-stomach, into which the nectar can be taken and kept separate from the actual food of the insect. The nectar or honey can be disgorged at will.

Attached to, or communicating with, the alimentary canal, there are two or three different kinds of glands, each

kind in pairs or in a number of pairs. The salivary glands open into the mouth, and in addition to possessing the function of moistening foods, they are often developed for quite different purposes. For instance, the silk glands of the silkworm and many other caterpillars, the poison glands of mosquitoes and of certain Hemiptera are salivary glands, or portions of the salivary glands specially developed for the purpose. Other poison glands, scent glands, and glands for many special purposes occur in insects, but quite apart from the digestive system. The kidney tubes, or 'malpighian' tubes, of insects communicate with the food canal, at the junction of the mid-gut with the hind-gut, that is where the stomach and small intestine join. These are often very numerous, and their function is excretory, similar to that of the kidneys in other animals. The waste products are passed into the intestine, and thence voided through the anus with the undigested food and other waste matter.

Reproduction.

Reproduction in insects is sexual, as a general rule, the organs of the two sexes being borne in separate individuals. Hermaphroditism (the two sexes in one individual) does not occur normally, and it is not known that hermaphrodite insects ever reproduce. The sexual organs are well developed, the testes of the male producing the spermatic fluid, and the ovaries of the female, the eggs. In the female of many species, the ovipositor is developed with special reference to the situation in which the eggs are to be laid. In the case of many bees, wasps, and ants, the ovipositors are often developed and used as stings, and as such are well known to most persons. Certain grasshoppers are able to force the abdomen into the ground for the purpose of egg-laying; thrips, the cane fly and others have a saw-like organ by means of which the eggs are deposited in incisions in the surface of the plant tissue.

Asexual reproduction occurs in plant lice, during a portion of the year, and in a few other insects. This parthenogenesis, as it is called, is a normal feature in the life-cycle, and the offspring consists of females. The queen of the honey-bee is able to lay, at will, fertilized eggs which produce female, and unfertillized eggs which produce male, forms. Another kind of asexual reproduction, known as

paedogenesis sometimes occurs in insects. The larvae of certain Cecidomyiidae are capable of giving birth to young, and in an another group of small flies the pupa deposits unfertilized eggs which are capable of hatching.

CHAPTER IV.

Orders of Insects.

It has been shown already (see p. 4) that the class Insecta is one of the four classes of Arthropoda. This is divided into orders, each of which includes individuals which have some prominent characteristic in common. Each order is separated from all the others by the fact that its members possess characters which are not shared by the members of any other orders.

The number of orders used in any classification may vary according to the purpose for which it is intended. In the present instance, for example, ten orders are considered; in a more careful analysis for systematic purposes, certain of these might be divided to form others. Carpenter (*Insects. Their Structure and Life*) employs fifteen orders, Comstock (*Manual for the Study of Insects*) nineteen, and Sharp (*Cambridge Natural History, Insects*, Vols. V, VI) carries out the careful division until thirty-five orders are provided.

When, as in the present case, only ten orders are used in the classification, some of these must include groups which differ slightly from the type of the order, but show a decided relationship to it.

Order I. Orthoptera. Straight-Winged Insects.

This includes cockroaches, crickets, mole crickets, grasshoppers, leaf insects, the godhorses, earwigs, and similar insects. Insects of this order have two pairs of net-veined wings, the first pair being thicker and stronger than the second, while the latter are large and

more delicate, and when at rest are folded lengthwise like a fan, under the first pair, which serve as covers for them. This straight, longitudinal folding of the wings provides the name of the order, which comes from the two Greek words *orthos*, straight, and *pteron*, a wing. The silverfish (see Fig. 8) are for convenience included in this order, although they are wingless. The metamorphosis is incom-

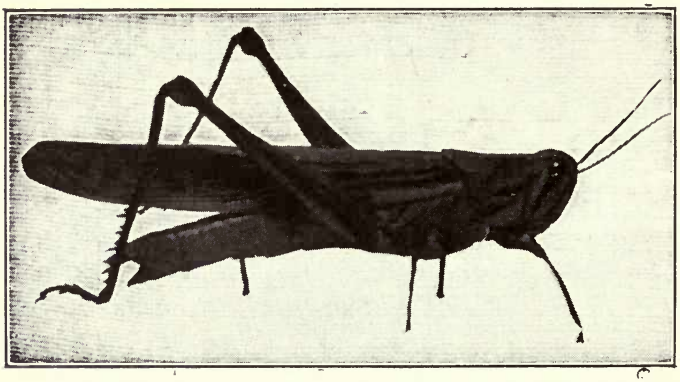

Fig. 15. Orthoptera. Grasshopper.
Slightly enlarged. (*Original.*)

plete; the mouth parts are formed for biting, in both larvae and adults.

The silverfish, a common household pest, which is one of the most primitive of insects, should really be included in another order—the Thysanura. The members of this order never possess wings; their mouth parts are formed for biting, but are not powerful; and their metamorphosis is incomplete. Only one insect of this order is mentioned in this book; and for the sake of convenience it has been referred to the Orthoptera, which include insects most closely related to the Thysanura.

Order II. Thysanoptera. Fringe-Winged Insects.

This order includes the insects known as Thrips. These are small, delicate insects with mouth parts formed for cutting and lapping. The first and second pairs of wings are similar in size and shape, and are bordered with a fringe of

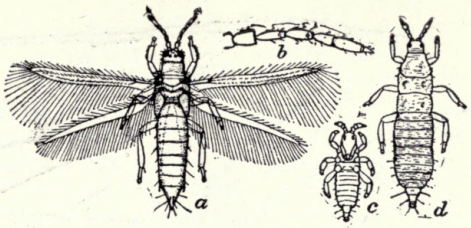

Fig. 16. Thysanoptera. Onion thrips.

(a) adult; (b) antenna of same; (c) young larva; (d) full-grown larva. All greatly enlarged. (From U.S. Dept. Agric.)

fine hairs. The name of the order comes from the structure of the wings, being derived from the two Greek words *thysanos*, a tassel, and *pteron*, a wing. Fig. 16 shows young and adult thrips, the latter with its delicate, fringed wings.

Order III. Hemiptera. Half-Winged Insects.

This order includes the true bugs, plant lice, scale insects and several parasitic forms such as the bed bugs and lice. The name of the order is derived from the Greek words *hemi*, half, and *pteron*, a wing, in reference to the fact that certain of these insects have the basal portion of the

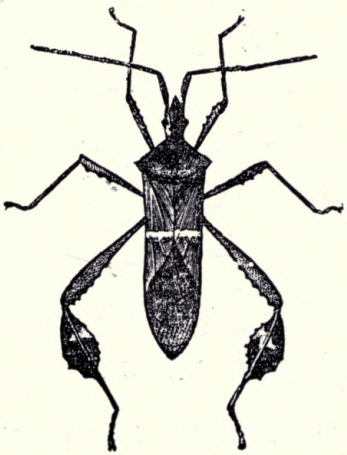

Fig. 17. Hemiptera. Leaf-footed plant bug.
Twice natural size. (From U.S. Dept. Agric.)

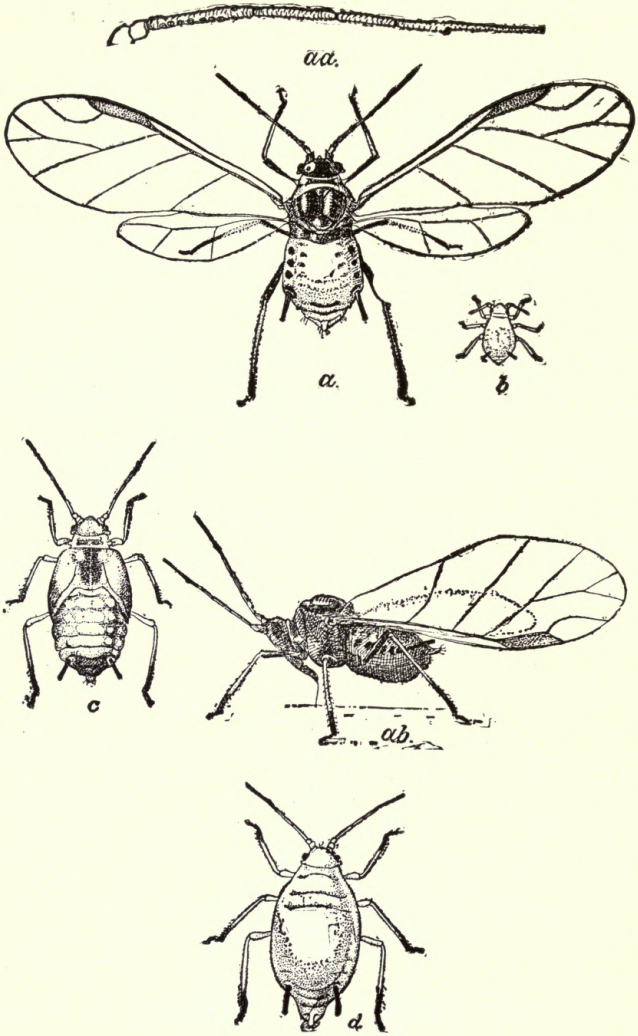

Fig. 18. Hemiptera. Melon aphis.
(a) winged female; (aa) enlarged antenna of same; (ab) dark female, side view, sucking juice from surface of leaf; (b) young or larva; (c) last stage of nymph; (d) wingless female. All greatly enlarged.
(From U.S. Dept. Agric.)

first pair of wings thickened, and the apical portion membranous. The metamorphosis in this group is incomplete; the mouth parts are formed for piercing and sucking in both the larval and adult stages.

This order includes insects showing great diversity in structure, especially with regard to wings, and in metamorphosis. In the case of many of the plant bugs (Fig. 17) with the typical structure of fore-wings as mentioned above, the second pair is membranous, and both sexes are winged. In the case of the white flies, cicads, leaf-hoppers and plant lice (Fig. 18) both sexes are winged, the wings of both pairs are membranous throughout, while in the scale insects (Fig. 19) the female is wingless and the male is provided with only one pair of membranous wings.

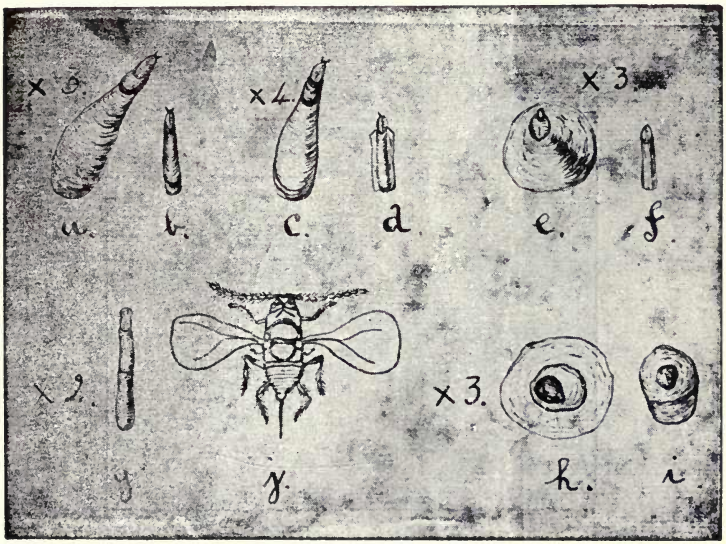

Fig. 19. Hemiptera. Scale insects, showing male and female scales, and a winged male insect.

All enlarged. (Imperial Dept. Agric.)

Order IV. Odonata. The Dragon Flies.

The dragon flies or pond flies are familiar to all residents in the West Indies by their swift, darting flight, the apparent delicacy of their structure, and often by their bright and irridescent colours. They are insects with biting mouth parts in both immature and adult stages of growth, and they are predaceous on insects or other forms of animal life, in both stages. The immature stages are passed in standing, or slowly-running, water. Pond-flies (Fig. 20) have two pairs of membranous, strongly nerved wings, of which the second or hind pair is often longer than the first.

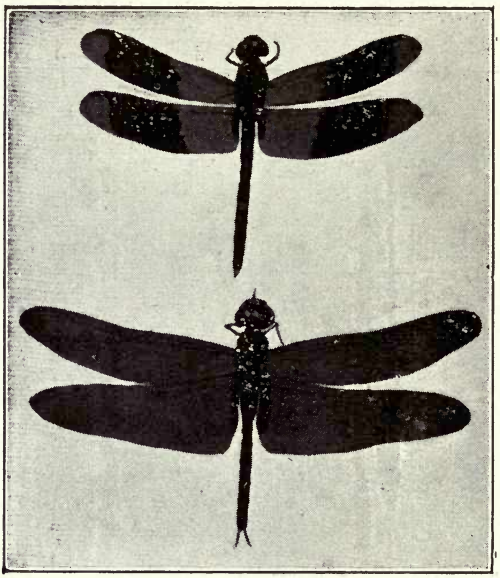

Fig. 20. Odonata. Pond-flies.
Both about natural size. (*Original.*)

The origin of the name of the order, which is thought to have come from the Greek word *odous*, a tooth, is not well understood.

Order V. Platyptera. Flat-winged Insects.

This order includes several groups of insects which were formerly considered in the old order Neuroptera. It comprises the families containing the Termites, the biting bird lice and the book lice. The termites, or white ants, are well known (Fig. 21); the bird lice are wingless parasites of birds

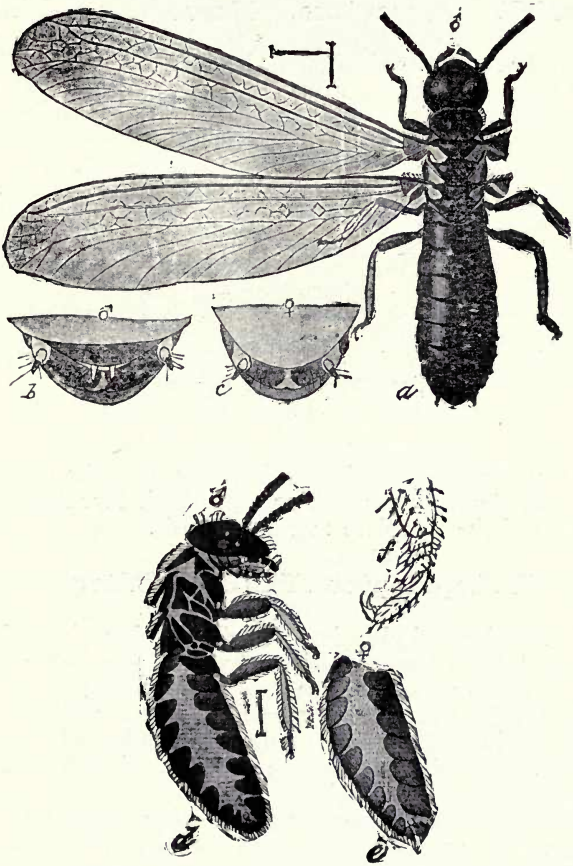

Fig. 21. Platyptera. White Ant.

(a) adult male; (b) terminal abdominal segments; (c) same of female; (d) male side view; (e) abdomen of female, side view; (f) tarsus showing joints and claw; a, d, e, enlarged; b, c, f, greatly enlarged. (From U.S. Agric.) Dept.

both wild and domesticated, while the book lice are the minute, fragile insects often seen in books and old papers. The insects of this order are characterized by the possession of biting mouth parts in the larval and adult stages of growth, and two pairs of membranous wings, the two pairs being similar in size and shape. The metamorphosis is incomplete.

Order VI. Neuroptera. Nerve-Winged Insects.

In this order are included the lace-wing flies (Fig. 22) and others similar in appearance. The principal distinguishing features are the two pairs of membranous wings

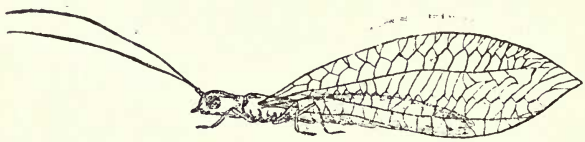

Fig. 22. Neuroptera. Lace-wing fly.
Enlarged. (*Imperial Dept. Agric.*)

with many nerves or veins, and cross nerves, the conspicuous antennae, the biting mouth parts, in both larval and adult stages, and the complete metamorphosis.

Order VII. Lepidoptera. The Scale-Winged Insects.

This order includes the butterflies and moths. (Fig. 23.) The chief characters are the two pairs of membranous wings covered with overlapping scales. The mouth parts in the larvae are formed for biting, while the adults either are not able to feed at all, or have mouth parts adapted to sucking the nectar of flowers or the juice of ripe fruits. The metamorphosis is complete. The name of the order is derived from the two Greek words *lepis*, a scale, and *pteron*, a wing. This order includes many pests to agriculture, such as the moth borer of the sugar-cane, the cotton worm, the giant moth borer, the potato moth and cut worms. Nearly all the injury caused by these insects is brought about by the feeding of the larvae. (Fig. 24.)

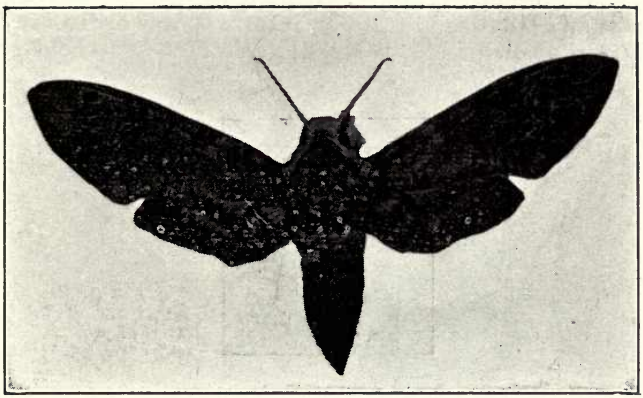

Fig. 23. Lepidoptera. Potato moth.
Slightly reduced. (*Original.*)

The adults are often beautiful in their colouring and the delicate patterns they exhibit. Some of the larger of them, especially some of the night-flying moths, are known as bats, molly boobys, etc.

Fig. 24. Lepidoptera. Full-grown caterpillar of moth borer.
Enlarged. (*Imperial Dept. Agric.*)

Order VIII. Coleoptera. Sheath-Winged Insects.

The members of this order have the first pair of wings thickened and horny, to form a sheath or cover for the membranous second pair, which are the true wings for flight. When at rest these latter lie folded under the first pair.

The wing covers (elytra) meet in a straight line down the back, protecting the wings and generally the entire dorsal surface of the abdomen. The mouth parts are formed for biting in both larval and adult stages of growth. The metamorphosis is complete. The name of the order is derived from the Greek words *coleos*, a sheath, and *pteron*, a wing.

The Coleoptera are the beetles, including hardbacks, weevils and lady-birds. Many insects of this order are injurious to growing crops, stored grain and household sup-

Fig. 25. Coleoptera. Root borer of sugar-cane.
Adult beetle, about natural size. (*Original.*)

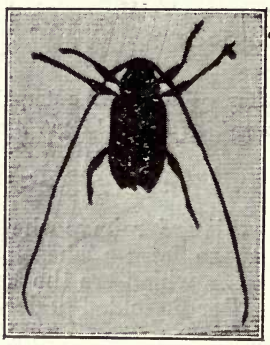

Fig. 26. Coleoptera. Lime tree bark borer.
About 1½ *times natural size.* (*Original.*)

plies. The root borer of the sugar-cane (Fig. 25), the long-horned borers (Fig. 26), the grain weevils, and the

Fig. 27. Coleoptera. A large beetle.
About 1½ times natural size. (Original.)

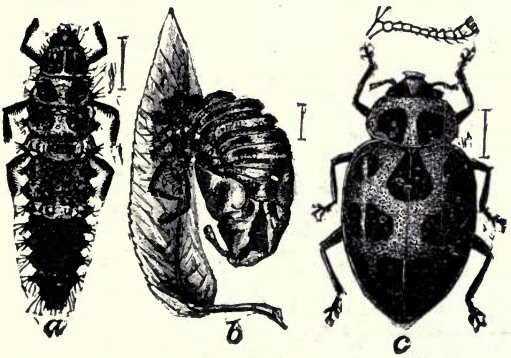

Fig. 28. Coleoptera. Lady-bird beetle.
(a) larva; (b) empty pupal skin; (c) adult with enlarged antenna above. All enlarged. (From U.S. Dept. Agric.)

cigarette and drug store beetles, are examples. The members of one family, the Coccinellidae (Fig. 28), are usually

highly beneficial from their habit of preying on other insects such as plant lice, scale insects and similar forms.

Order IX. Diptera. The Two-winged Insects.

The chief characteristic of this order is the fact that the adults never have more than one pair of wings. The first pair is developed, the second being represented by small structures called halteres or balancers.

This order includes the true flies. These insects are very numerous, and are diverse in habit, but all agree in the possession of one pair of wings, the complete metamorphosis and the mouth parts in the adult formed for piercing and sucking, or for lapping. The name of the order is derived from the Greek words *dis*, two, and *pteron*, a wing.

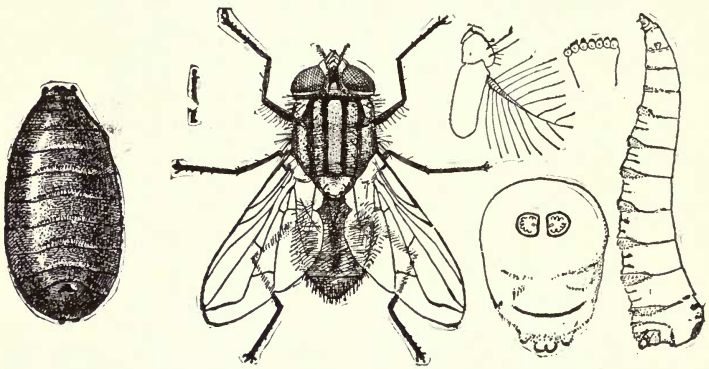

Fig. 29. Diptera. House-fly.
Puparium at left; adult next; larva and enlarged parts at right. Enlarged. (From U.S Dept. Agric.)

Representatives of the order are the house-fly (Fig. 29) the blow fly, mosquitoes (Fig. 30), and sand flies (merry-wings). The larvae are maggots, or, in the case of mosquitoes, water wrigglers. They live in a variety of situations according to their manner of life. Some are scavengers, breeding in manure and decaying organic matter ; others attack the leaf, flower, fruit or stem of plants ; while others are direct parasites on man or on the lower animals. Some are distinctly beneficial on account of their habit of preying upon, or of parasitizing, other insects.

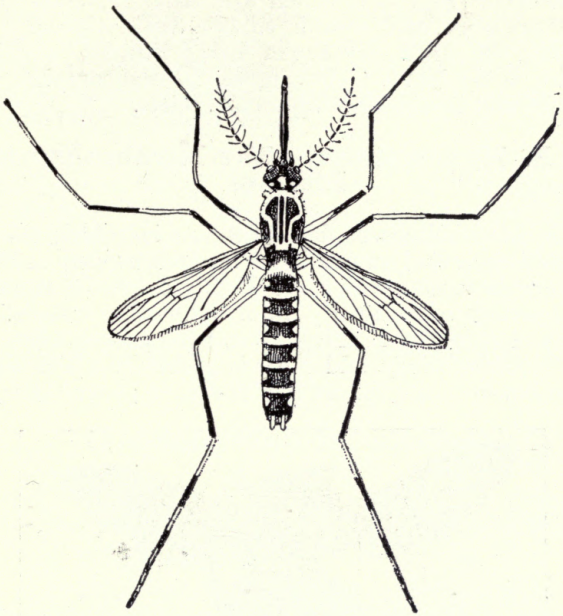

Fig. 30. Diptera. Yellow fever mosquito.
Enlarged. (*From U.S. Dept. Agric.*)

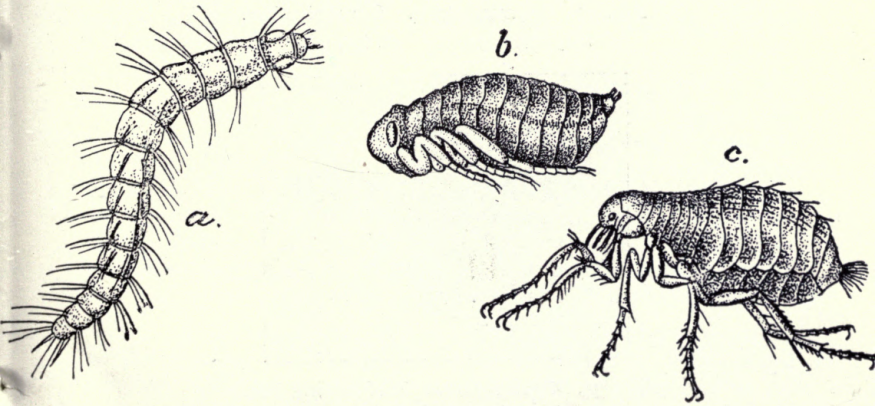

Fig. 31. Diptera. House flea.
(*a*) *larva*; (*b*) *pupa*; (*c*) *adult flea. All enlarged.*
(*From U.S Dept Agric.*)

The fleas (Fig. 31), which are often included in the Diptera, are sometimes considered as a distinct order. They differ from the other Diptera in being wingless, and in the structure of the larva. They agree in the complete metamorphosis and in the sucking mouth parts.

Order X. Hymenoptera. The Membrane-winged Insects.

The order includes such well-known insects as the bees, wasps and ants, and an enormous number of very small and inconspicuous insects which are highly beneficial from their habit of living parasitically in or upon other insects. The members of this order (Figs. 32 and 33) possess two pairs of membranous wings, and there is generally a distinct constriction between the thorax and abdomen ; sometimes, as in

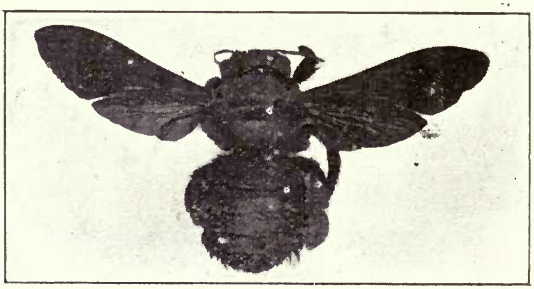

Fig. 32. Hymenoptera. Carpenter bee.
Slightly reduced. (*Original*)

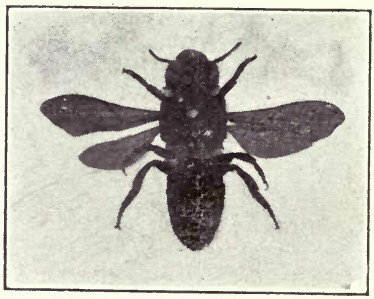

Fig. 33. Hymenoptera. Leaf-cutting bee.
About 1½ times natural size. (*Original.*)

the case of the mason bee, a very long, slender pedicel connects the two. Good examples of this order are the Jack Spaniards, wild bees, cow bees, mason bees, and the honey bee, as well as the great number of ants and parasites. The name of the order is derived from the Greek words *hymen* membrane, and *pteron*, a wing.

The larvae of the Hymenoptera are in most cases legless grubs with biting mouth parts. In the case of the adults the mouth parts are adapted for biting and sucking, both these adaptations sometimes being found in the same individual, as in the case of the honey bee and other long-tongued bees.

Key to the Orders of Insects Mentioned in this Paper.

Directions for Using the Key.

Certain readers of this book will not be accustomed to using such a key as that which follows. For them, the following explanation of its working is given.

If you have collected an insect and wish to know to which order it belongs, compare the insect with headings, successively as indicated, beginning with the first two. You will find every time two sets of characters, with the same headings, to choose between, and the next reference is indicated by the letters on the right [as, see (b)] until the correct order is indicated, where its name and number will be found (as, Order IV, Odonata).

To take an example: suppose you have a dragon fly. Compare the first two characters; you may not know the young form, but as the references are to A and B, you try the first of these. Examination of the specimen shows that it has biting mouth parts. Refer to (a) and compare the wings, and you find the next reference is (c). Here the choice is between large insects living where they are conspicuous, and small and inconspicuous insects. You readily find the reference to come out at Order IV, Odonata.

It must be remembered that there are many exceptions to the general rules, and you may find insects that do not appear to be accounted for anywhere in the key. For instance, there are beetles in which the front wings are entirely

undeveloped, and moths where the females are wingless. It would be impossible within the limits of the available space, to adapt the key to include adequate reference to the exceptional cases, but this will not interfere with its usefulness in connexion with the more common forms.

The characters by means of which insects may be distinguished from ticks are chiefly the absence of wings, and the possession of four pairs of legs, in the case of the ticks, while the adult insect is, normally, winged and provided with only three pairs of legs. (See also p. 5.)

KEY.

Insects with incomplete metamorphosis, the life-cycle consisting of three distinct stages of development, egg, larva (or nymph), and (imago). There is no quiescent pupal stage, during which the wings and other organs characteristic of the adult are developed ... ... See A.

Insects with complete metamorphosis, the life-cycle consisting of four distinct stages : egg, larva, pupa and adult (imago.) The pupa is a distinctly quiescent stage during which occurs the complete transformation from the grub, maggot, or caterpillar to the winged, sexually perfect adult ... ... See B.

A. Insects with biting mouth parts ... See (a)

A. Insects with piercing and sucking mouth parts ... ... See (b)

(a) The first pair of wings somewhat thickened and horny, serving as covers for the membranous second pair, which are larger and fold longitudinally, like a fan ... ... Order I, Orthoptera.

(a) Two pairs of membranous wings similar in size, shape and structure, the second pair sometimes larger than the first. The wings do not fold ... ... See (c)

(b) Small to minute insects, with fringed wings, living entirely on plants and within flowers . . ... Order II, Thysanoptera.

(b) Small to moderate-sized insects ; generally with a distinct proboscis, or sucking mouth

parts. Wingless (female scale insects), with two pairs of membranous wings (white flies, leaf hopper, etc.), or with two pairs of wings, the first of which is thickened at the base and membranous at the tip, beneath which the larger, membranous second pair is folded (true bugs) ... ... Order III, Hemiptera.

(c) Large insects, conspicuous in the adult condition, strong of flight. The larvae are aquatic ... ... Order IV, Odonata.

(c) Small insects, living in colonies and constructing nests and covered galleries, winged adults appearing only at certain periods (Termites); wingless parasites, solitary in habit, living in the plumage of birds, or in the fur of animals (the biting lice); or minute insects, sometimes wingless, which are found in old books, papers, etc. (the book lice) ... Order V, Platyptera.

B. Insects winged. ... ... See (d)

B. Insects wingless: Parasitic insects, with thin, flattened bodies and much-developed hindlegs adapted for leaping. Fleas ... ... Order IX, Diptera.

(d) Insects with one pair of wings ... ... Order IX, Diptera.

(d) Insects with two pairs of wings ... See (e)

(e) Wings clothed with scales ... ... Order VII, Lepidoptera.

(e) Wings not clothed with scales ... See (f)

(f) Wings of the first pair thickened, meeting in a straight line down the back, forming a cover for those of the second pair, which are membranous and folded beneath ... ... Order VIII, Coleoptera.

(f) Wings of both pairs membranous See (g)

(g) Wings with many cross veins, larger in proportion to size of the body ... ... Order VI, Neuroptera

(g) Wings with few or no cross veins, small in proportion to size of the body .. ... ,, ... Order X, Hymenoptera.

CHAPTER V.

Insect Pests of Crops.

COTTON.

THE COTTON WORM (*Alabama argillacea* Hübn.) Lepidoptera.

The cotton worm is an insect native to tropical America, and has been known ever since cotton has been cultivated in these regions. It occurs in all the West Indian Islands; but in St. Vincent alone, it has not occurred in sufficient numbers to cause any damage since the re-establishment of the cotton industry some nine or ten years ago. In the other islands, notably Barbados, Montserrat, Antigua, Nevis and St. Kitts, this pest has been so abundant at times that fields of cotton have been completely defoliated So rapid is the feeding by the nearly full-grown caterpillars that many persons have believed that the attacks develop in a night; the caterpillars had not been observed in their younger stages, and it was thought that they were able to reach enormous numbers in this short time.

The cotton worm occurs in all the cotton-growing districts of tropical and sub-tropical America, and in the adult stage has been found far outside these limits. No other food plant than cotton is known, and it therefore does not breed in any locality where this plant cannot be grown.

The Egg. The eggs are laid on the under side of the

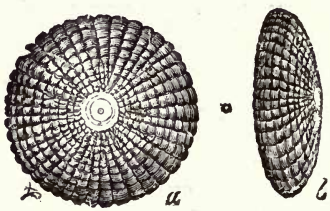

Fig. 34. Eggs of cotton worm.
(a) seen from above; (b) from the side. Greatly enlarged.
(From U.S. Dept. Agric.)

tender leaves at the growing tips of the cotton plant. They are very small, pale-green objects, circular in outline when seen from above, and somewhat flattened as viewed from the side (Fig. 34). If one is examined with a magnifying glass, the surface will be seen to be marked with fine lines or ridges radiating from the centre, above. The eggs are laid singly—not in clusters as in the case of those of many moths. The duration of the egg stage is about four or five days.

The Larva. The larva of this insect is a caterpillar; when first hatched this is very small and of the colour of the leaf. For the first few days it feeds on the epidermis and soft tissues on the under side of the cotton leaf. As it gets older, the jaws become very strong and the entire tissue of the leaf is eaten, except the largest veins. The full-grown larva (Fig. 35) measures about 1½ inches in length. The general colour is green, with a very fine bluish white line running along the middle of the back for the entire length of the body. This is bordered on either side by a broad green band, and each of these in turn by one of yellowish green. There are rows of black spots each surrounded by a white ring, and each bearing in its centre a stiff hair or bristle.

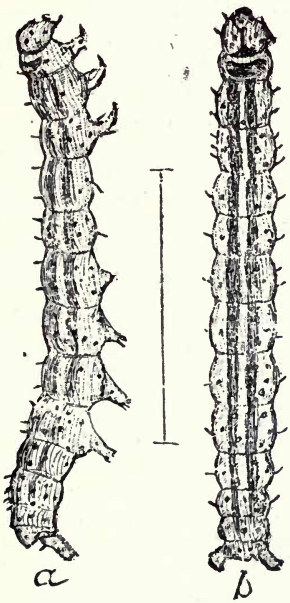

Fig. 35. Cotton worm larva. *(a) side; (b) dorsal view. Redrawn after U S Dept Agric. (Enlarged)*

The larval stage lasts for about twelve to fourteen days, ordinarily, development being more rapid in hot and moist weather than in the cooler or drier seasons.

The Pupa. When the caterpillar has become full-grown, it ceases feeding and transforms into the pupa, within a portion of leaf folded over and secured by means of a few silken threads, forming a scant cocoon. The pupa is at first greenish in colour soon changing to dark-brown; it is about ½-inch

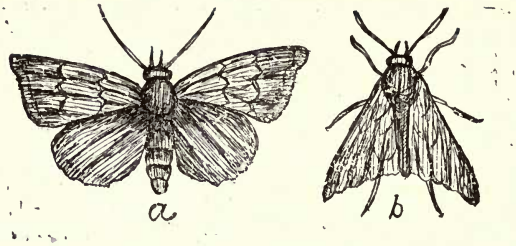

Fig. 36. Cotton Worm.
(*a*) *Moth with wings spread*; (*b*) *with wings closed. Natural size.* (*Redrawn. After U.S Dept. Agric.*)

in length, nearly cylindrical, and broadly rounded at the anterior and pointed at the posterior end.

The Moth. The adult insect (Fig. 36) is a small, olive-grey moth with a spread of wings of about 1½ inches. The forewings are marked with several wavy dark lines, and with one or two small bluish-white spots. The moth flies at dusk, hiding by day and coming out to feed and deposit eggs in the late afternoon and early evening. Egg-laying begins a few days after the moths emerge, each female laying a large number, with an average of 300.

Remedies. The cotton worm is controlled by the use of arsenical poisons, of which Paris green and London purple have given the best results in the West Indies. These poisons are applied dry, mixed with lime in the proportion of 1 lb. of the poison to 5 or 6 lb. of dry air-slaked lime. This mixture is dusted on to the plants from bags of strong cloth, such as ticklingburg, which has a fairly close mesh, but one that allows the poison to pass through with a little shaking.

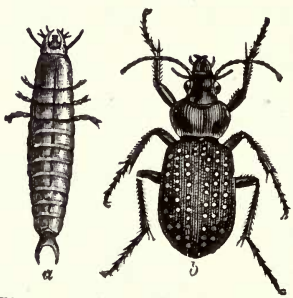

Fig. 37. Fiery Ground beetle.
(*a*) *larva*; (*b*) *adult. Natural size.* (*From U.S. Dept Agric.*)

Natural Enemies. The cotton worm has many natural enemies which exercise a very large degree of control over its abundance, and it is probable that this pest is often held in check by these means to such an extent as to render it quite inconspicuous for considerable periods of time. The natural enemies are of many kinds: birds, toads and lizards devour both the caterpillar and the moth. The caterpillars are also eaten by the fiery ground beetle (*Calosoma calidum*—Fig. 37) which is known to occur in St. Vincent and Barbuda, and by the wild bee or Jack Spaniard (*Polistes annularis*—Fig. 38) and other related insects. The caterpillars and pupae are parasitized by the hymenopterous parasites such as the Chalcis flies (*C. annulata*), by certain dipterous flies, and the eggs are attacked by minute parasitic insects such as *Trichogramma pretiosa*, Riley, and Telenomus, of which there are several species. The accompanying illustration (Fig. 39) shows *Chalcis ovata*,

Fig. 38. Wild bee or Jack Spaniard.
About 1½ times natural size. (Original)

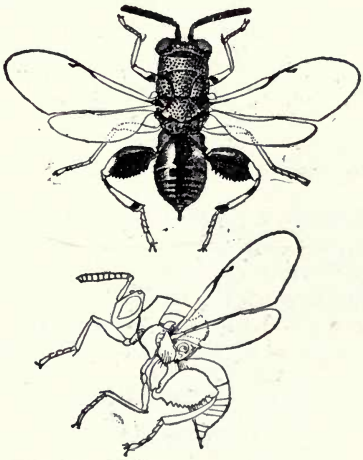

Fig. 39. Hymenopterous parasite.
Enlarged. (From U.S Dept. Agric.)

an American parasite of the cotton worm, which is similar in appearance to the West Indian species.

THE LESSER COTTON WORM (*Aletia luridula*, Guen.). Lepidoptera.

In habits and appearance, and in its manner of feeding, this insect is very similar to the preceding one. In the larval stage it differs from the cotton worm in being slightly smaller and, when nearly full-grown, in having a reddish or pinkish tinge of colour. It also hides itself more completely during the day, and it may happen that in a field where this insect is abundant no caterpillars will be seen until one has learned to look carefully into the bracts surrounding the flower and pod. It differs also in the manner and place of pupation. The full-grown larva of the lesser cotton worm enters into the soil at the base of the plant, where it forms an earthen cell in which the pupal stage is passed. The adult insect is slightly smaller, with a suggestion of reddish or pinkish in its dull, greyish colour.

The lesser cotton worm probably occurs throughout the West Indies, but in only one instance has it been recorded as being sufficiently numerous to attract attention as a pest. This occurred in Barbados in one season, and as far as could be seen, this species was the only cotton worm in a very badly infested field.

This insect is controlled by the same means as the cotton worm, and is probably held in check by the same natural enemies.

COTTON STAINERS (*Dysdercus* spp.). Hemiptera.

Cotton stainers, of which several species are known in the West Indies, are small insects with mouth parts fitted for puncturing the tissues and sucking the juices of plants. The eggs of these insects are small, ovoid, glistening objects with a smooth surface, which are dropped loosely in the opening cotton bolls or upon the ground beneath the cotton plants or among cotton seed either in the ginneries or on the ground. The young of all the species mentioned are reddish in colour, the red being often tinged with yellow or black. In the adult condition the species are more easily separated by their colour markings than in the immature stages of growth.

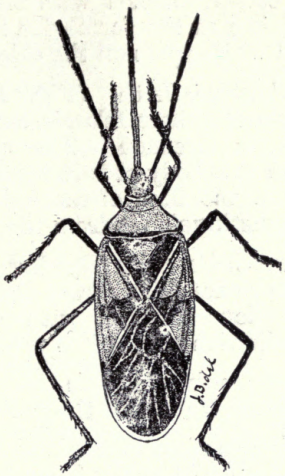

Fig. 40. Cotton Stainer. (*D. andreae.*)
Three times natural size (*Imperial Dept. Agric*)

Dysdercus andreae, Linn. (Fig. 40) is found in the Northern Islands, as far south as Gaudeloupe. This species

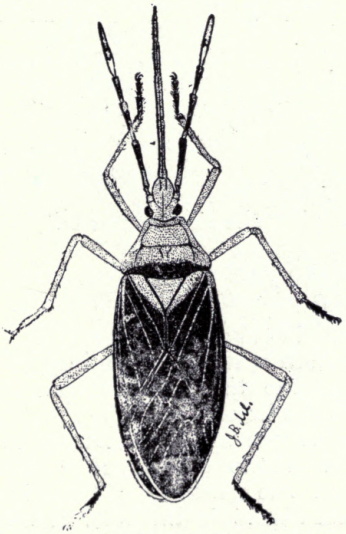

Fig. 41. Cotton Stainer. (*D. delauneyi.*)
Three times natural size. (*Imperial Dept. Agric.*)

is red in general colour, marked with black and white, the white markings being in the form of a St. Andrew's Cross on the wings, and white spots on the sides.

Dysdercus delauneyi, Leth. (Fig. 41), is the common cotton stainer of the Southern Islands, extending in its range from Montserrat to Grenada. The general absence of white markings on the body of this insect and the presence of a white band on the base of the apical segment of the antennae serve to distinguish it from the preceding.

In Grenada, another species (*Dysdercus fernaldi*, Ballou) also occurs. This species differs from *D. delauneyi* in having the red ground colour suffused with yellow to such an extent that the yellowish tinge often predominates.

Barbados is the only island in the West Indies where cotton stainers are not known at the present time.

The several species of cotton stainers, though differing in appearance, are all alike in habit. They feed on the growing bolls, the seed, and probably also on the leaf and tender stems of the cotton plant. It has not often happened that they have occurred in such numbers as to prove serious pests in these islands, during the past few years ; but their power of rapid increase in numbers and the absence of natural enemies give to these insects considerable importance as possible pests. It is recorded that cotton stainers were largely responsible for the downfall of the cotton industry in the Bahama Islands, some forty years ago.

In addition to feeding on cotton in the field, cotton stainers swarm about all buildings where cotton seed and seed-cotton are stored, finding food and opportunities for breeding. The seed of the silk cotton tree is also a favourite food, while such plants as the musk ochro (*Hibiscus Abelmoschus*), ochro (*H. esculentus*), anodyne or seaside mahoe (*Thespesia populnea*), and other malvaceous plants are often found to harbour these insects.

Mention has been made of the injury to the plant from the puncturing of the tissues and the sucking of the juice. The name stainer has its origin in the fact that cotton lint is discoloured by these insects. The staining is brought about by the deposition of the excrement of the insects in the opening bolls, from the crushing of them in the gins, and probably also from disease in the bolls which gains entrance through the punctures made by the insects in feeding.

Control. Cotton stainers may be controlled by spraying, collecting and trapping, and much may be done by removing outside sources of food, as far as possible, during the season when no cotton is available for them.

Spraying with any good contact insecticide by means of a knapsack sprayer would be effective, but this is an expensive method that will rarely be employed in the West Indies. Collecting has proved cheap and effective. This operation is carried out by means of tins containing water and kerosene, into which the labourers jar or shake the young stainers.

The insects may be attracted to bits of sugar-cane, small heaps of cotton seed, seed of silk cotton and ripe mangoes, where they may be killed while feeding by means of hot water, kerosene or crushing.

Any useless plants in the vicinity of cotton fields known to harbour these insects should be destroyed, and great care should be taken to prevent scattered seed from accumulating around ginneries and store-houses.

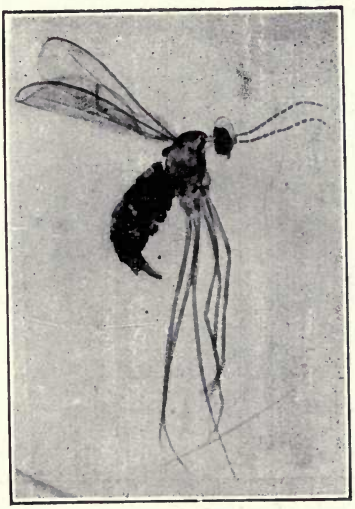

Fig. 42 Flower-bud maggot.
The adult insect. About 25 times natural size. (*Original.*)

THE FLOWER-BUD MAGGOT (*Contarinia gossypii*, Felt.).
Diptera.

The flower-bud maggot is the larva of a very small fly (Fig. 42) which lays its egg in the young flower buds of

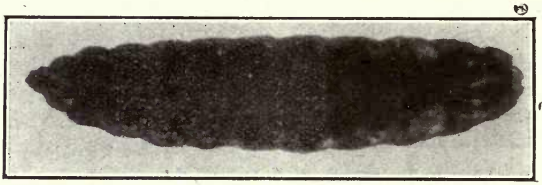

Fig. 43. Flower-bud maggot.
The larva. About 30 times natural size. (*Original.*)

the cotton plant. The larvae (Fig. 43) feed on the developing essential organs, causing the death of the bud, and consequently preventing the formation of the boll. The bracts surrounding the base of the attacked flower-bud gen-

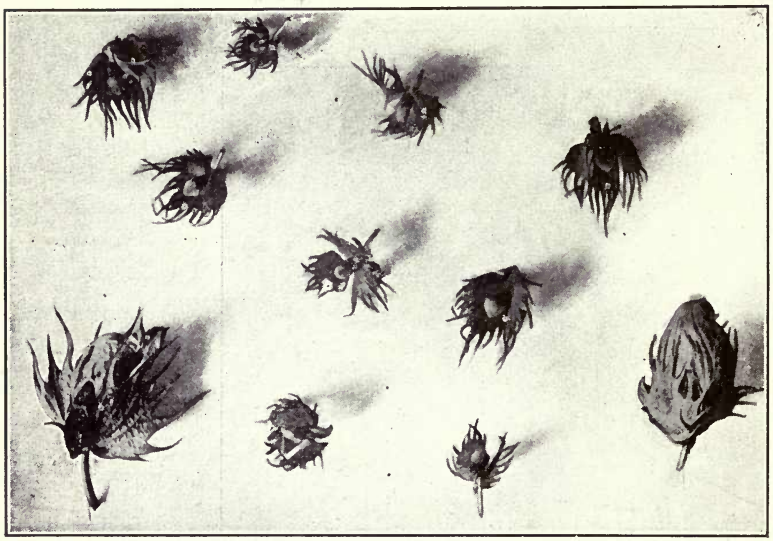

Fig. 44. Flower buds of cotton, showing flaring of bracts resulting from attack of flower-bud maggot.
Reduced. (*Original.*)

erally flare back (Fig. 44) instead of remaining close around the base, as in the normal flower, and this serves as an indication of attack before the buds drop. The adult insect, the parent fly, is so very small that it is probably never observed in the field upon or about the cotton plants. The length of the body is only about $\frac{1}{25}$-inch and the spread of the wings is about $\frac{1}{8}$-inch. The maggots, which are very small (about $\frac{1}{12}$-inch in length when full-grown), are yellowish, or pinkish in colour, leave the bud as soon as it falls to the ground and enter the soil, where they pupate.

The flower-bud maggot first made its appearance in Antigua at the end of 1907, where it caused very serious losses in the cotton crop at that time. It has been recorded from Antigua each year since then, but has not appeared as a pest in any other island. The attacks in 1907-8 and 1908-9 in Antigua lasted about three months—December, January and February. The attacks in the two succeeding seasons have been less severe and of shorter duration.

Control. No satisfactory means of control have been devised. The practice of early planting, which will allow the forming of the bolls before the time for the attack of the flower-bud maggot to commence, will enable a crop to be produced. The time of planting in Antigua is influenced very largely by the weather conditions, which sometimes make early planting difficult in that island. This condition, and the habits of this pest cause its control to be a matter of difficulty.

Natural Enemies. It is likely that minute hymenopterous insects prey upon the flower-bud maggot, but it is not possible to say how far they exercise any control over it.

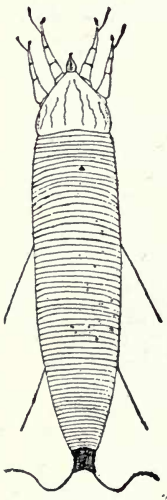

Fig. 45. Leaf-blister mite of cotton.

Greatly enlarged. (From N. Y. Entom. Soc.)

THE LEAF-BLISTER MITE (*Eriopyhes gossypii*, Banks). Acarina.

The leaf-blister mite (Fig. 45) attacks all parts of the cotton plant except the roots. The blisters which are characteristic of this mite (Fig. 47) are distortions or swellings, which result from its presence, and are

probably due to an irritation in the tissues of the plant caused by its feeding. They are lined with a thick growth of very fine hairs (Fig. 46), among which the mites live. The leaf-blister mite is almost microscopic in size. It is so small that even when very abundant the individual mites can scarcely be seen, even with the aid of a good magnifying glass. The amount of injury done by the pest is sometimes very severe, but the loss from this cause has been less since planters and others have become more familiar with it.

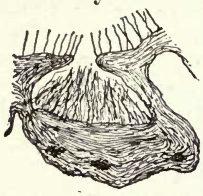

Fig. 46. Section through gall made by leaf-blister mite on cotton leaf.
Greatly enlarged.
(From N.Y. Entom. Soc.)

The leaf-blister mite first occurred as a pest of cultivated cotton in Montserrat, in 1903. It was soon afterward found to be attacking cotton, both wild and cultivated, in all the other islands of the Leeward and Windward groups. It has not, however, made its appearance in Barbados.*

Fig. 47. Cotton leaf attacked by leaf-blister mite.
Reduced. (Original)

* *Since this pamphlet has been in the press the leaf-blister mite has been found on cotton in Barbados (Feb. 1912).*

Control. The leaf-blister mite is best controlled by the destruction of all old cotton plants immediately after the crop is reaped, and the picking off of infested leaves as soon as they appear on the young plants. On every estate and in every district where the leaf-blister mite is abundant, there should be a period of several weeks between the destruction of the old plants and the planting of the next crop. All wild cotton near the fields should be cut, as a further precaution. A mixture of lime and sulphur, applied as a dust on the plants, has been found useful in checking the increase of this pest in the case of serious attack on young plants. The mites are so well protected by the deformities of the plant in which they live, that they are practically out of the reach of any insecticide. Lime and sulphur would only come into contact with them if the mites left the galls to travel across the surface of the leaf. This would probably only happen when the full-grown mites left the old galls in search of young leaf buds in which to deposit eggs and thus provide for the infestation of the developing leaves.

THE BOLL WORM (*Heliothis obsoleta*, Hübn.). Lepidoptera.

This is perhaps one of the most cosmopolitan of all insects, being found in most parts of the temperate and tropical regions of the world. It is a very general feeder, for it attacks and thrives on a great variety of plants, generally preferring the fruit to the leaves.

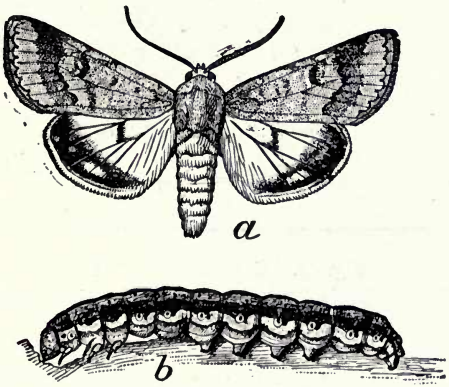

Fig. 48. Cotton boll worm.
(*a*) *moth* ; (*b*) *larva. Slightly enlarged* (*From U. S. Dept Agric.*

As a pest of corn it has caused great losses in the Southern States of America, and it is known as a pest of tomatoes, tobacco, peas and beans, and many other crops, as well.

The parent moth varies from a light to a dark-grey in

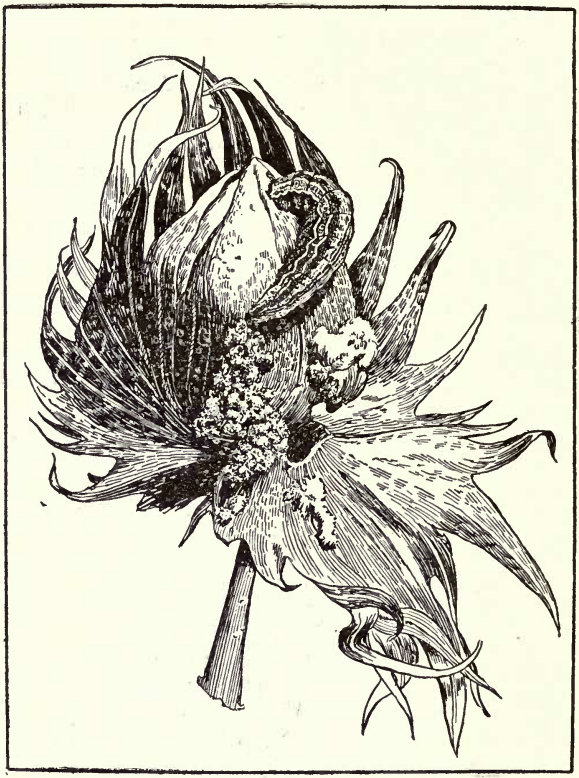

Fig. 49. **Cotton boll worm.**
Showing mode of attack on cotton boll. Natural size.
(From U.S. Dept. Agric.)

colour, and measures about 1½ inches across the outstretched wings. The female moth, which flies in the dusk of evening

and at night, lays its eggs scattered over the food plant. The larvae vary much in colour and markings. The more common form is of a greyish green colour on the sides, with two darker stripes along the back, separated by a narrow light stripe. The pupa is formed in the ground, 2 or 3 inches below the surface, in a small earthen cell within which the caterpillar encloses itself after feeding and growth have been completed. The life-cycle occupies about six weeks The caterpillar tunnels into the cotton bolls (Fig. 49), completely destroying the interior, and indeed often entirely consuming the contents of them.

The corn ear worm (*Laphygma frugiperda*, S. and A.) Fig. 50—also occurs as a boll worm of cotton in the West Indies. Neither of these insects is known as a serious pest of cotton in these islands, although both are known to occur, and both are pests of Indian corn.

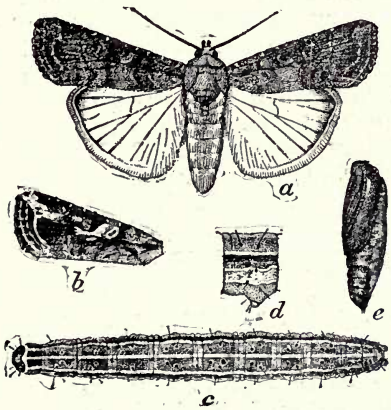

Fig. 50. Corn ear worm.

(a) moth; (b) forewing; (c) larva; (d) abdominal segment of larva, lateral view; (e) pupa, lateral view. (d) twice natural size. a b, c e one fourth natural size. (From U. S. Dept. Agric.)

Control. The destruction of infested bolls containing the larvae will result in reducing considerably the numbers of these insects. Measures for control when they attack Indian corn should also be useful for reducing their numbers as cotton pests. The use of Paris green or other arsenical poison on the cotton plants assists in the control of these pests, since the larvae feed on the leaves for a short time and have to eat their way into the bolls, and they may be poisoned in so doing.

Trap Crops. It is sometimes possible, when the insects become numerous, to plant corn and cowpeas near cotton fields, at a time that they will be attractive to the egg-laying moths, before the cotton bolls are formed; so that the

eggs will be mostly laid in these crops instead of in the cotton. These traps would be of no use unless they were removed and fed to stock, or otherwise disposed of, before the caterpillars are full-grown, so as to accomplish their destruction. If they are allowed to remain until the moths emerge, the traps merely provide for increased infestation of the cotton.

THE RED MAGGOT (*Porricondyla gossypii*, Coquillett). Diptera.

The red maggot is the larva of a small fly related to the flower-bud maggot, and like that one, is too small to be seen and recognized. It was first discovered in Barbados in 1903, and in one or two seasons since that time has been fairly abundant. In 1905, a very large proportion of the cotton plants in certain fields was destroyed. The red maggot occurs under the bark of the stem of the cotton plant. The maggots when full-grown are nearly $\frac{1}{6}$-inch in length and of a reddish colour. They feed upon the soft tissue of the bark and developing wood. When the feeding of these insects extends completely around the stem, it causes the death of all the portion beyond that spot. The presence of the red maggot is always indicated by a discoloured and shrunken area of bark. It has not occurred as a pest in any of the islands except Barbados although it has been recorded from Montserrat. The attacks of this insect have been made in rather singular manner, no field or estate having reported a severe attack in two succeeding years. For its control it is necessary that any plants seen to be affected should be pulled up, or the affected part cut out and promptly burned. Old cotton plants should be destroyed as soon as the crop is reaped.

THE COTTON APHIS (*Aphis gossypii*, Glover). Hemiptera.

The cotton aphis is a small, greenish insect, often to be found on the under side of the leaves of cotton and other plants. It has sucking mouth parts, and when it occurs in extreme abundance causes serious injury to the plant. The aphis, plant louse or green-fly, as it is commonly called, is usually more abundant in dry, than in wet, weather.

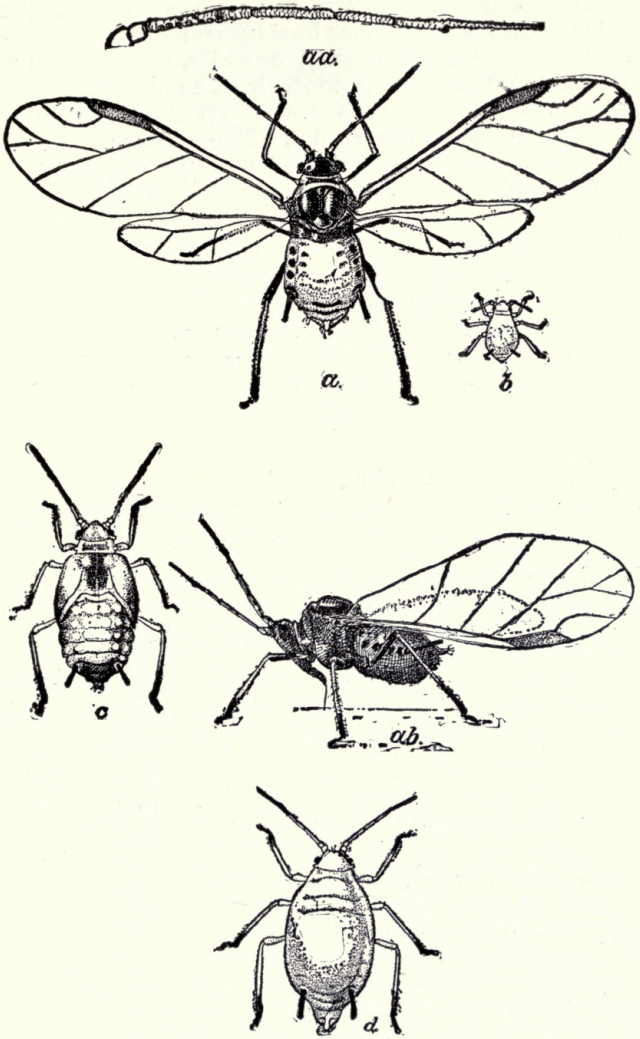

Fig. 51. Melon aphis.
(*a*) *winged female*; (*aa*) *enlarged antenna of same*; (*ab*) *dark female, side view, sucking juice from surface of leaf*; (*b*) *young or larva*; (*c*) *last stage of nymph*; (*d*) *wingless female. All greatly enlarged.*
From U.S. Dept. Agric.)

Control. If it is desired to apply remedial measures for the control of aphis, spraying with kerosene emulsion or whale oil soap would be the best treatment. This insect, however, is attacked by natural enemies, which often are able to hold it in complete control. The most important of the natural enemies are the several species of lady-birds which occur in the West Indies. The spotted lady-bird (*Megilla maculata*, var., De Geer), and the red lady-bird (*Cycloneda sanguinea*, L.), are shown at (Fig. 52). Certain

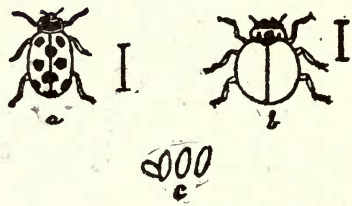

Fig. 52. Lady-birds.
(*a*) *Spotted lady-bird ;* (*b*) *Red lady-bird ;* (*c*) *eggs. Enlarged.*
(*Imperial Dept. Agric.*)

species of aphis, are known to be attacked by hymenopterous parasites, and by parastic fungi. The fungi develop much more rapidly under moist conditions, and would exert more influence in the control of aphis in wet, than in dry, weather. This fact, and the fact that heavy rains wash the aphis off the leaves of plants, would explain perhaps why these insects are more troublesome in the dry season.

THE CUT WORM (*Prodenia* spp.). Lepidoptera.

Cut worms are the larvae of certain night-flying moths There are in the West Indies several closely related species which are all alike in general habit. These caterpillars live in the ground and feed on the roots of plants and on the stems of young seedlings. One of these, *Prodenia ornithogalli*, is shown in the illustration (Fig. 53). Cotton plants are often attacked, the second or third day after they appear above ground. Cut worms can be controlled by the use of poisoned bait, which is applied on the surface of the ground or lightly covered with soil at the time that the seeds are planted.

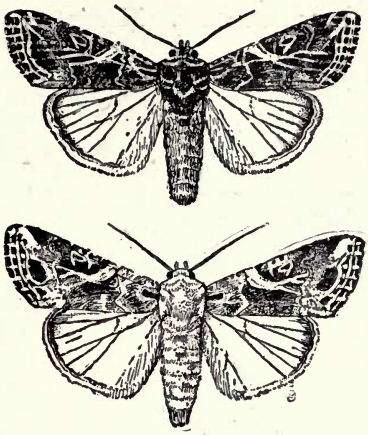

Fig. 53. Cut worm.

Dark form, male, above; pale form, female, below. Somewhat enlarged. (From U. S. Dept. Agric.)

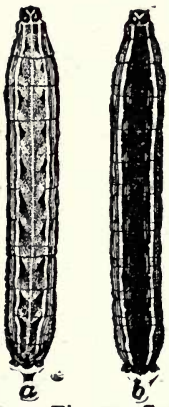

Fig. 54. Cut worms.

(a) pale form (b) dark form of larvae.
(From U.S. Dept. Agric.)

A poison bait which has been used with good success in Barbados, in controlling cut worms in cotton fields, was made by mixing 25 lb. bran (pollard) and 1 lb. Paris green to a thick paste with water, to which a sufficient quantity of molasses has been added to sweeten the mixture. This bait is used by throwing down a small handful (one or two tablespoonfuls) at each hole when the seed is planted. The cut worms eat the poisoned mixture, and are killed before the seedlings come up, and the injury is prevented.

SCALE INSECTS. Hemiptera.

Cotton in the West Indies has been attacked by two species of scale insects which are commonly known as the black scale and the white scale. The black scale (*Saissetia nigra*, Nietn.) has been a very serious pest, especially in

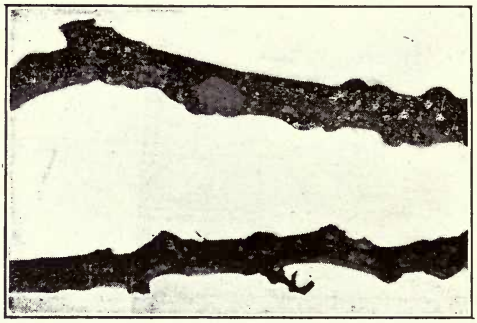

Fig. 55. Black scale on cotton.
Slightly enlarged. (*Original.*)

Barbados, where in 1905, several fields of cotton were a total loss owing to the severity of the attack of this pest. At the present time, black scale attracts very little attention and has ceased to be regarded as a pest by most planters. This changed condition has been brought about by the development of the parasite of the black scale. This beneficial insect is now known to occur throughout the West Indies.

It was first reared from the black scale in Barbados in 1907, and specimens were submitted to the United States Department of Agriculture for identification. Through the courtesy of Dr. L. O. Howard, Chief of the Bureau of Entomology, these were studied by Mr. J. C. Crawford, who found the insect to be a species new to science, to which he gave the name *Zalophothrix mirum*. The insect is very small (about $\frac{1}{12}$-inch in length), at first glance resembling a small ant with rather short wings. Its general colour is dark-brown, the head bearing conspicuous reddish brown eyes; the transparent wings are crossed by a broad dark band near the middle. The egg of the parasite is deposited by the female under the body of the scale insect, about the time that the latter begins to produce eggs. The parasite grub hatches in the midst of

the scale insect eggs and feeds upon them. Generally, only one parasite grub is to be found under each scale, but in a few instances two have been seen.

When its growth is finished, the parasite changes from a fat, whitish grub to a pupa which, when first formed, is light-coloured, and later is almost black. At the completion of the pupal stage the adult Zalophothrix emerges through a round hole in the back of the scale insect.

An abundance of scales punctured in this way indicates an efficient percentage of parasitism, but it must be remembered that such scales are dead and that the parasites have left them. Other full-grown scales on the same plant will probably contain the grub or pupa of the parasite.

In the event of an attack of black scale occurring in a field of young cotton, it would be advisable to introduce the parasite in order that the control of the scale might be begun as soon as possible. Old cotton plants in which there is an abundance of black scale should be pulled up after the cotton is reaped, and piled in the field for two weeks before they are burned or otherwise destroyed. This will give the nearly mature parasites an opportunity to emerge, and being winged, they will be able to fly into adjoining wild land in search of scales in which to deposit eggs; many of the scale insects will die for want of food as the plants become dry, since they are not able to travel far, and the few that succeed in establishing themselves on other plants will in all probability become so severely attacked by parasites that they will be practically killed out.

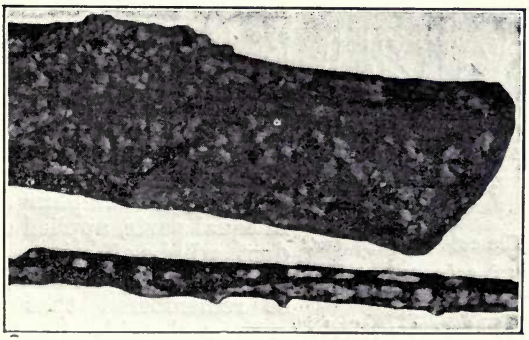

Fig. 56. White scale on cotton.
About 1½ times natural size. (Original.)

The white scale (*Hemichionaspis minor*) has not often occurred as a serious pest of cotton in the West Indies. This is due to the fact that it is held in check by parasitic insects. The parasites of the white scale are very minute, almost miscroscopic in size, but their effect is very beneficial. The presence of these parasites may be determined by the punctures in the scales, as in the case of the black scale, and t is likely that in the event of a serious attack of this pest, parasitized material might be introduced in the same manner as is suggested for the black scale.

RED SPIDER (*Tetranychus gloveri*, Banks). Acarina.

Cotton is sometimes, especially in very dry weather, attacked by a very small mite, the cotton red spider, which lives on the under side of the leaves. Enormous numbers of this mite occur on each leaf, and the effect of their feeding is to cause the leaves to dry up. The red spider can be distinguished only by careful examination of the infested leaves, when it may be seen actively running about often under or among the very delicate threads of a sparse web. Small patches of a reddish colour, in the body of certain of the mites, will probably be the first thing to attract the eye to these small, but very harmful, organisms.

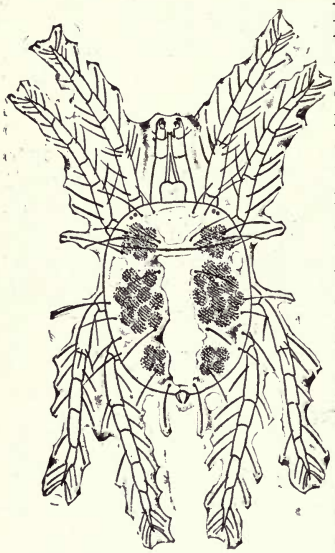

Fig. 57. The cotton red spider. *Adult, much enlarged.* (*U. S. Dept. Agric.*)

If it becomes necessary to resort to remedial measures for the control of the red spider, the use of any contact insecticide, or of sulphur and lime, in equal parts, applied dry as a dust will be effective. In making such an application, it must be remembered that the red spider lives almost entirely on the under side of the leaf, and therefore, it is necessary to apply the insecticides to this place.

Up to the present time, the red spider has not been sufficiently abundant to render the application of insecticides necessary.

THE BOLL WEEVIL (*Anthonomus grandis*, Boh.). Coleoptera.

The boll weevil of cotton is not known in the Lesser Antilles, and it is greatly hoped that it may never be introduced. Since this insect made its entrance to the United States from Mexico in 1894, it has developed into one of the most serious pests on record, and there seems to be no possibility of stopping its steady progress eastward to the Atlantic Coast.

The accompanying figures (58 and 59) are given in order to show what the insect is like in its different stages of growth. The fine line in Fig. 58 shows the exact length of the weevil.

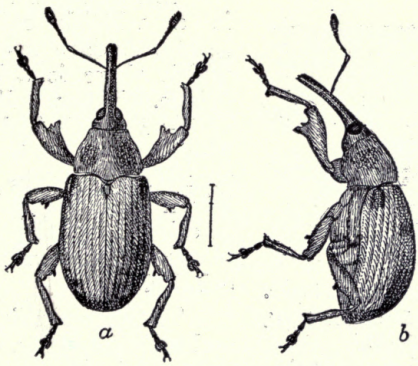

Fig. 58. Boll weevil. Adult insect.
Enlarged. (From U. S. Dept. Agric.)

Fig. 59. Boll weevil. Larva and pupa.
Enlarged. (From U. S. Dept. Agric.)

The introduction of the boll weevil into the Lesser Antilles would in all probability put a speedy end to the cotton industry.

SUGAR-CANE.

MOTH BORER (*Diatraea saccharalis*, Fabr.). Lepidoptera.

The moth borer is one of the most serious of all the pests of sugar-cane in the Lesser Antilles. It is known throughout the sugar-growing regions of tropical and sub-tropical America, of which it is probably a native. It also attacks Indian corn in much the same manner as it affects sugar-cane. The parent is a whitish or straw-coloured moth, with dark spots on the wings. The wings, when spread, measure about 1½ inches. The injury done by this pest to the cane results from the tunnelling of the larva in the stems.

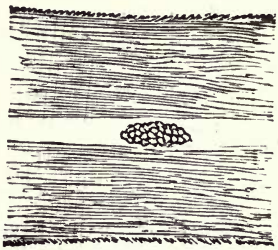

Fig. 60. Eggs of moth borer. *Enlarged.* (*Imperial Dept. Agric.*)

The larva of the moth borer is a whitish caterpillar with scattered dark spots, in each of which there is a black hair or bristle. When full-grown, it is about 1 to 1¼ inches in length. The pupa, which is formed in the tunnel made by the larva, is about ⅔-inch in length, dark brown in colour, and the abdominal segments are set with short, stiff bristles.

The eggs of this insect are flat and scale-like (Fig. 60). They are laid on the leaves of the sugar-cane in clusters of twenty to thirty. The larva (Fig. 61), soon after hatching, travels down the leaf to its base, which in young canes is near the growing point. It bores its way into the stem, where it spends the remainder of the larval and the pupal stages. When the pupal stage is completed the moth (Figs. 62 and 63)

Fig. 61. Full-grown caterpillar of moth borer. *Enlarged.* (*Imperial Dept. Agric.*)

emerges from the pupa case and from the tunnel in the cane. The time occupied in the life-cycle of this insect is about fifty days.

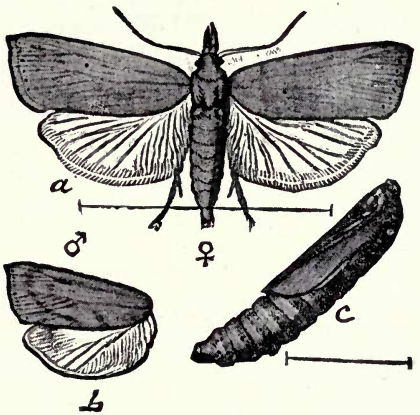

Fig. 62 Moth borer.
(a) female moth; (b) wing of male; (c) pupa. Enlarged. (From U. S. Dept. Agric.)

Fig. 63. Moth borer *Adult in resting position. Enlarged. (Imperial Dept. Agric.)*

Control. No canes should be used for planting which give evidence of the presence of moth borer; all so employed should be treated with Bordeaux mixture. The dead shoots which occur owing to the attacks on the young canes should be cut out; but in order for the removal to be effective, it must be done before the base of the shoot has begun to decay, since the caterpillar leaves the decaying shoot and attacks another. Also, it is necessary in cutting out dead shoots to make the cut below the borer, so that it will not be left behind. Dead shoots should be collected and fed to stock as soon as possible after cutting.

As the eggs are laid on the surface of the leaf, they may easily be collected; and children can be taught to do this work satisfactorily at very small cost. At the time of reaping, any canes which are so badly affected by moth borer as to be worthless for

milling should be destroyed, preferably by burning, in order to prevent the emergence of any immature insects which may be present in them. The practice of destroying all rotten and insect-affected canes has an important bearing in connexion with otherpests and diseases of sugar-cane.

Natural Enemies. The moth borer is attacked by small parasitic insects which destroy the eggs. One of these (*Trichogramma pretiosa*) is shown, much enlarged, in Fig. 64. The female parent of the parasite inserts its eggs into the eggs of the moth borer. When the eggs of the parasite hatch they produce minute grubs which destroy the developing moth borer in each egg attacked in this way. Moth

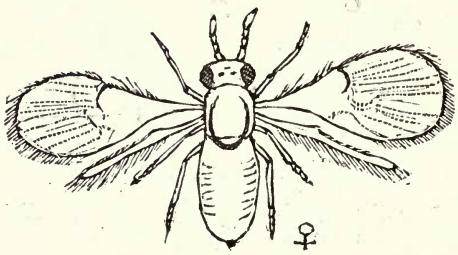

Fig. 64. Parasite of the eggs of the moth borer
Much enlarged. (*Imperial Dept. Agric.*)

borer eggs which contain the parasite can be distinguished from those which are not parasitized by their darker colour. When eggs are being collected, those parasitized should, if possible, be left in the field, but as it is difficult to carry out this practice satisfactorily, it would be better to have all collected eggs brought to the edge of the field, to the mill yard or a similar place, and put into large trays. The parasites on emerging would be able, in their winged condition, to fly back into the field in search of fresh eggs to attack. The newly hatched caterpillars could be prevented from leaving the tray by means of a small trough containing water, fastened around the top edge of the tray, or by a band of some sticky substance such as molasses, tar or tanglefoot, which would prevent the larvae from crawling out. After three or four days the collected leaves should be thrown into cattle-pens, where any caterpillars would be destroyed either by being eaten or by being trampled with the manure.

THE LARGER MOTH BORER (*Castnia licus*, Drury).
Lepidoptera.

The eggs of the larger moth borer are elongate and pointed at both ends. The surface is marked with five or six longitudinal ridges. They are laid inside the leaf base near the ground, or on the ground among the canes. The larvae, on hatching, tunnel into the stem, and work upwards for a distance of some 2 feet, when they turn and go down through the same tunnel into the underground portion of the cane stool. The larva reaches a size of $2\frac{1}{2}$ inches in length, and $\frac{1}{2}$-inch in diameter. The tunnel is consequently large, and the injury to the cane very severe. The pupal stage is passed in the cane, or in the soil near the underground portions. The time occupied in the life-cycle ranges from twelve to fifteen weeks. The adult insect

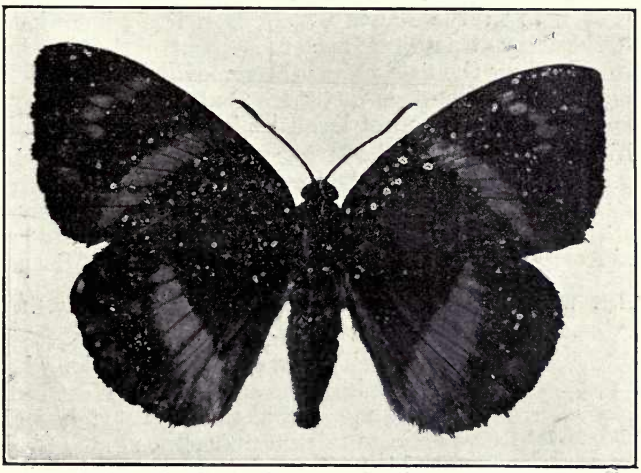

Fig. 65. Larger moth borer of the sugar-cane.
Reduced. (*Original.*)

(Fig. 65) is a large day-flying moth, which in general appearance is very similar to the large butterflies.

Castnia licus is a native of South America. Its original food plants were species of the Orchid family and of the family of plants to which the pine-apple belongs (Bromeliaceae). It is distributed over a large portion of the northern part of South America, and extends northward to Mexico ; it has been known in Trinidad for several

years. In British Guiana, it has been a serious cane pest in certain localities for a number of years, and in Trinidad it is known to attack sugar-cane and bananas. It has also been reported, as a pest of sugar-cane, from Surinam. It is not known at present to occur in any of the islands north of Trinidad, and every precaution should be taken to prevent its introduction into any of these islands. If cane plants are to be imported from any colony or country where this pest occurs, only the tops should be admitted, and these should be carefully examined for any signs of the eggs or larvae at the base of the leaves. Cane trash should never be imported, on account of the possibility of introducing the eggs. Any trash accidentally accompanying imported cane plants should be rigorously burned.

Control. No satisfactory system of control has yet been devised for the larger moth borer. Collecting the moths by means of nets in the hands of children has given better results than any other direct measure of control that has been tried. Flooding the fields after the removal of the crop has had a good effect in certain instances ; but this practice could not be carried out in most localities in the Lesser Antilles.

Natural Enemies. The larger moth borer, being a day-flying insect, is largely attacked by many insectivorous birds, and by lizards and toads. It is likely that the encouragement of natural enemies in British Guiana will be found to have a considerable influence in decreasing the numbers of the pest.

THE WEEVIL BORER (*Sphenophorus sericeus*, Oliv.).
Coleoptera.

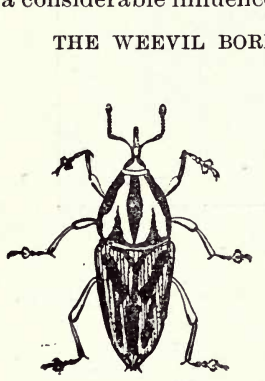

Fig. 66. Weevil borer.
Adult. Enlarged. (Imperial Dept. Agric.)

The weevil borer has long been familiar throughout the West Indies as a pest of sugar-cane. It has also been known under the name of lady-bird borer, the term lady-bird apparently being applied in the West Indies to a considerable number of weevils. This is rather unfortunate, since in most other parts of the world the insects referred to as lady-birds are generally beneficial in their habits, while the weevils are all distinctly injurious.

The weevil borer has been sufficiently abundant at times to

cause a considerable amount of injury, a large proportion of the canes being attacked, and many of these having almost the whole of the interior eaten out. Young plant canes and stumps left for ratooning are also subject to serious attack.

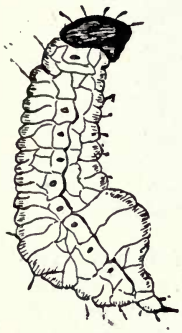

Fig. 67. Weevil borer. *Grub. Enlarged. (Imperial Dept. Agric.)*

The adult weevil (Fig. 66) is about $\frac{5}{8}$-inch in length, dark-brown in colour, with darker markings on the wing covers and thorax. The snout, or beak, is slender and strongly curved. The larva (Fig. 67) is a footless grub which makes its way through the tunnels in the canes by means of the large ventral hump of the abdomen. The grub, when full-grown, measures from $\frac{1}{2}$-inch to $\frac{1}{4}$-inch in length.

The eggs (Fig. 68) of this insect are oval, about $\frac{1}{16}$-inch in length, and almost transparent. They are laid singly, embedded in the cane to a depth of $\frac{1}{6}$-inch, generally in cut or broken canes and in the soft part of the cane above the hard joints. The beetle appears unable to penetrate the hard rind of a mature joint of cane. The larva is a small, white grub which tunnels in the cane, and when larval growth is completed it makes a rough cocoon (Fig. 69) out of the fibres of the cane. The pupal stage is passed in this cocoon, from which the adult beetle emerges. Generally, only one grub is found in a joint of cane. Egg-laying begins soon after the mating of the sexes, and is continued for some time. The life-cycle occupies a period of something over sixty days, of which four are spent in the egg stage, about fifty in the larval stage, and about ten in the pupal stage.

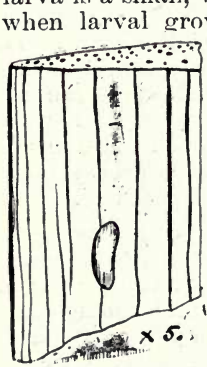

Fig 68. Eggs of weevil borer in cane. *Enlarged. (Imperial Dept. Agric.)*

Control. All rotten or infested canes should be destroyed as soon as possible. Stumps intended for ratooning should be covered with mould, as should also plant canes, when this insect is known to be abundant, so as to prevent the access of the weevils for the purpose of egg-laying. Cane stumps not intended for ratooning should be dug up and burned as soon as possible.

Fig 69. Cocoon or weevil borer.
Natural size. (*Imperial Dept. Agric.*)

Natural Enemies. No parasites of the weevil borer seem to be recorded in the West Indies. It is likely that birds, toads, and lizards capture and devour considerable numbers of the weevil. If infected stumps could be dug out and broken up, the weevil grubs would fall a prey to birds and ants.

THE ROOT BORER (*Diaprepes abbreviatus*, L.).
Coleoptera.

The root borer occurs generally throughout the West Indies, but is known as a serious pest of cane only in certain parts of Barbados. This insect (Fig. 70) is also known as the lady-bird and has apparently been a common insect in Barbados for many years, but there seem to be no records of its occurrence as a pest until quite recently.

Fig. 70. Root borer of sugar cane.
A dult beetle. A bout natural size. (*Original.*)

The root borer lays its eggs on the leaves of a variety of plants, (Fig. 71) and the young larvae fall to the ground and immediately begin feeding on young roots. In the cane fields, they seem to feed on the root of the cane for a considerable part of the larval period, bu t later they tunnel into the underground stem portions of the plant. Fig. 72 shows the tunnels made by these grubs. The grubs do not seem to penetrate the canes above the ground level They appear to be able to emigrate

through the soil from one stool of canes to another, and they have been found several inches below the roots of the

Fig. 71. Eggs of root borer of sugar-cane.
Enlarged. (*Original.*)

cane, in the soil. The life-cycle of this insect occupies about a year, of which about 10 days are spent in the egg stage, some 300 in the larval stage (Fig. 73), 15 in the pupal and about 20 in the adult, during which latter period mating and egg-laying take place. The adult is a large weevil, about $\frac{3}{4}$-inch in length, pale-green in colour, with dark, bronze stripes running longitudinally on the wing covers.

Fig. 72. Root borer.
Tunnels in cane made by the grub.
Reduced. (*Original.*)

Control. No satisfactory method of control has been found. It has been noted on one estate, at least, that where canes follow canes in the same fields in the same year, the attacks of root borer are much worse than in fields that have been rested ; that is, fields that have not been returned to canes for eighteen months or more after reaping, either with or without an intermediate crop. It seems likely that careful investigation will reveal points in the life-history of this insect which are considerably different from those supposed in our present knowledge, especially as to the length of life in the larval condition. The present recommendations are that in

infested localities canes should not follow canes on the same land in the same year, and that when intervening crops are planted these should not be Indian corn, Guinea corn or sweet potatoes, as the roots of all of these are readily eaten by the root borer. The second recommendation is that all stumps in infested fields should be dug out, broken up and burned, as soon as possible after the crop is harvested. The breaking up of the stumps exposes many of the grubs to attack by natural enemies such as blackbirds and ants, and the burning of them will have an additional useful effect in connexion with the control of the root disease of sugar-cane. Carbon bisulphide and a solution of cyanide of potash have been tried for the control of the root borer. These are applied by injecting them to a depth of 8 or 10 inches in the soil by means of a special injector. Poisonous fumes are given off, and are supposed to travel through the soil, killing any grubs with which they come into contact. The experiments so far carried out have not given results which justify the recommendation of the expensive practice of soil injection. As far as Barbados is concerned, the impervious nature of the soil in those localities where trials have been made of carbon bisulphide and cyanide of potash probably very largely reduces the effectiveness of these insecticides.

Fig. 73. Grub of root borer. *Enlarged.* (*Imperial Dept. Agric.*)

During the present year (1911) large numbers of the adult of this insect have been collected on estates in Barbados, by children, and destroyed. On account of favourable rains in February and March, it was possible to plant Indian corn on an estate in that island, where the attacks of root borer had been very severe in the ripening cane, so that fields from which the canes had been reaped were planted with this crop; in June it was found that the root borer weevil was hiding among the leaves of the corn plants in considerable numbers. Collecting was at once begun, and during a period of about four weeks some 30,000 of the insects were captured and destroyed on one estate; on other estates the collecting was carried out to a much smaller extent. The beetles were found hiding among the leaves of the pigeon pea, sweet potato, and bonavist

bean, and rarely among the canes. The eggs have not been found in the field. This suggests the planting of Indian corn on lands where root borer attacks have been severe, in order to furnish a hiding place for the weevils, so that when they emerge they may be collected. There can be no doubt that the destruction of large numbers of the adults greatly reduces the number of grubs which will attack the following crop of canes, and if there were concerted action on the part of all the estate managers in any district, the root borer in that district might easily be reduced to comparatively small numbers.

Natural Enemies. The adult weevil, the parent of the root borer grub, is probably preyed upon to a certain extent by birds, toads and lizards. The grubs, during the longer part of their existence as such, are very largely protected from attack by the situations in which they live, but when they are exposed on the surface in the operation of hoeing or forking, or when the cane stumps are dug out and broken up, they are readily attacked by several species of ants, and eaten by toads and by birds, especially by the Barbados blackbird (*Quiscalus fortirostris*).

THE SHOT BORER (*Xyleborus perforans*, Woll.). Coleoptera.

This is a small, brownish beetle about $\frac{1}{10}$-inch in length It tunnels in the canes like the weevil borer, spending the stages of egg, larva and pupa in the tissues of the food plant. It is supposed that the shot borer causes the chief injury to canes by providing easy means of entrance for disease-producing fungi. There seems to be some doubt, however, as to whether healthy canes are often attacked.

The shot borer has been known for many years throughout the West Indies. It appears to have been most abundant during those years when the sugar industry seemed threatened by the extraordinary attacks of fungus diseases. For several years very little has been heard of the attacks of this pest in the Lesser Antilles.

Control. The prompt destruction of all infected and rotten canes, immediately after the crop is reaped, will have the effect of reducing the numbers of the shot borer, and checking its development and spread.

THE CANE FLY (*Delphax saccharivora*, Westw.). Hemiptera.

The cane fly lives on the leaves and stems of the cane, procuring its food by sucking the juices of the plant by means of its proboscis, with which it is able to penetrate

Fig. 74. Sugar-cane attacked by cane fly.
(*Original.*)

the epidermis of the leaf and the tender part of the stem near the growing point. The eggs are deposited within the tissue of the leaf, in slits which the female cane fly

Fig. 75. Cane fly adult.
Much magnified. (*Imperial Dept. Agric.*)

makes with the saw-like ovipositor. The presence of the cane fly is often first indicated by the black fungus which grows on the canes wherever these insects occur in considerable numbers. In fact, the cane fly was

formerly called black blight, planters and others not distinguishing between the insects and the fungus.

The cane fly has not occurred as a serious pest in the West Indies for a number of years. It is probably of general distribution and has been known for a long time. It is mentioned in Schomburgk's *History of Barbados* as occurring in great numbers in Grenada after the hurricane of 1831. At that time it is said to have caused the loss of half the entire crop of sugar, in certain sections.

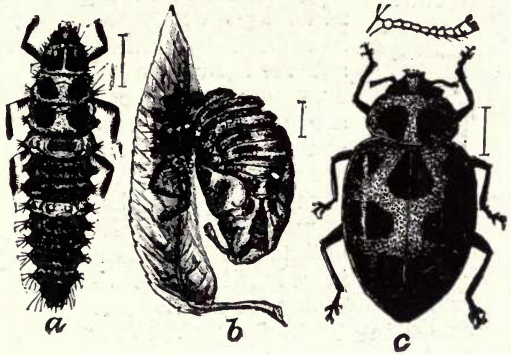

Fig. 76. Lady-bird beetle.
(*a*) *larva*; (*b*) *empty pupal skin*; (*c*) *adult, with enlarged antenna above. All enlarged.* (*From U.S. Dept. Agric.*)

Natural Enemies. Under ordinary conditions the cane fly is well held in check by its natural enemies, of which the lady-birds and the green lace-wing fly are the most

Fig. 77. Lacewing fly, with eggs at right.
(*Imperial Dept. Agric.*)

important, so far as is known at present. It is probably on account of the action of these insects that the cane fly is not often a pest.

THE PINK MEALY-BUG (*Pseudococcus calceolariae*, Mask.). Hemiptera.

The pink mealy-bug (Fig. 78) does not often occur in the West Indies in sufficiently large numbers to cause it to

be classed among the serious pests, but it is capable of increasing to such an extent as to bring about a considerable amount of injury. In Louisiana, where it is fostered and protected by the Argentine ant (*Iridomyrmex humilis*), this insect has developed into a very serious pest. It occurs under the leaf sheath, where it sucks the sap from the cane by means of its slender mouth parts. Sugar-cane, especially ratoon canes suffering severely from root disease, have been observed to be rather badly attacked by the pink mealy-bug. This circumstance may arise on account of the possible fact that canes suffering from fungus disease are more suitable for the development of mealy-bug than healthy canes, and it may also result from the planting of infested cane plants. The insects introduced at the time of planting would have had opportunity for development and would be well established during the early growth of ratoons.

Fig. 78. Pink mealy bug of the sugar cane. *Enlarged.* (*Imperial Dept. Agric.*)

This insect has a general distribution throughout the West Indies.

Control. It does not often happen that any direct remedial measures are necessary in dealing with the pest, but the greatest care should be taken that no cuttings should be used for planting which are infested by this mealy-bug.

Natural Enemies. It is probable that the pink mealy-bug is held in check by natural enemies, especially parasitic Hymenoptera. No definite record of this parasitism seems, however, to be available.

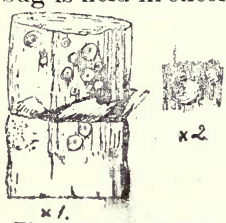

Fig. 79. Sugar cane aspidiotus. *Enlarged.* (*Imperial Dept. Agric.*)

THE SUGAR-CANE ASPIDIOTUS (*Aspidiotus sacchari*, Ckll.) Hemiptera.

This is a rounded scale insect of a light straw colour (Fig. 79) which occurs on sugar-cane, under the sheathing bases of the old leaves, and sometimes underground. It is rarely abundant, and probably does but little

harm to the plant. No treatment can be given plants in the field. Care should be taken not to plant infested canes.

THE GREY SUGAR-CANE MEALY-BUG (*Pseudococcus sacchari*, Ckll.). Hemiptera.

This is a moderately large insect, covered with mealy wax, and not easily distinguished from the pink mealy-bug. The grey colour, longer legs, and the less rounded body are the distinguishing characters. No treatment in the field is possible, but the grey mealy-bug does not often occur in sufficient abundance to become a serious pest. Care should be taken not to plant infested canes.

THE GRASSHOPPER (*Schistocerca pallens*, Thunb.). Orthoptera.

Sugar-canes are sometimes injured by attacks of grasshoppers (Fig. 80) which eat the leaves, especially of the young canes. In St. Kitts, grasshoppers are more of a pest to sugar-cane than in the other islands. These insects may

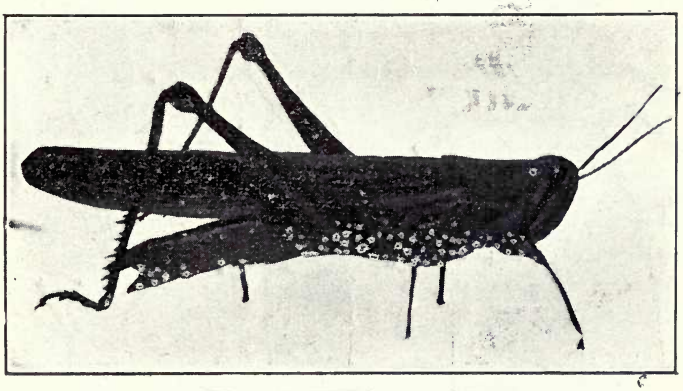

Fig. 80. Grasshopper.
Slightly enlarged. (*Original.*)

be controlled by use of a poisoned bait, and their numbers may be greatly reduced by collecting by hand. The latter method has been employed with good results in St. Kitts. The smaller birds, and turkeys and fowls, feed readily on grasshoppers, and probably the wild birds exert a considerable influence over the abundance of the insects, and on estates where they are particularly common it would probably pay to keep large flocks of turkeys and fowls.

A satisfactory poison bait may be made by using 1lb. bran (pollard) mixed to a stiff mash with water and molasses and Paris green, 25 lb. or an equally efficient and much cheaper bait may be employed, composed of ½-barrel of fresh horse droppings, 1lb. salt and 1lb. Paris green, thoroughly mixed together. This is the Criddle mixture and has given good results in the United States and Canada.

TERMITES, OR WHITE ANTS. Platyptera.

Termites (Fig. 81) are well known in the tropics, chiefly on account of the injury they do to the timbers of buildings, etc., but in St. Kitts, on one estate, they have occurred as

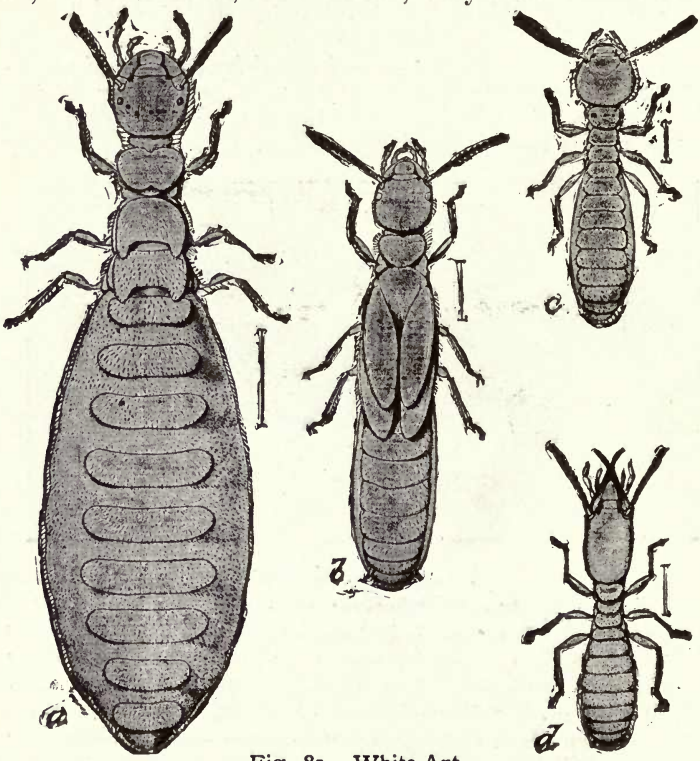

Fig. 81. White Ant.

(a) queen ; (b) nymph of winged female ; (c) worker ; (d) soldier. All enlarged. (From U. S. Dept. Agric.)

a serious pest of sugar-cane; when this happens the ripening canes are attacked, and the entire internal portion eaten out. No nests of these insects could be found in or near the fields in which the attacks occurred, and no remedy was applied.

Areas in these fields, including more land than that actually infected by termites were planted with cotton for two or three years. The termites do not seem to feed on the roots of the cotton, and as these fields have since been replanted in canes and no return of the termites observed, it would seem that this practice is successful.

CITRUS FRUITS.

Scale Insects. Hemiptera.

Citrus trees in the West Indies are attacked by several species of scale insects of which the most important is the mussel or purple scale (*Lepidosaphes beckii*). The green scale (*Coccus viridis*) has in the past few years developed to a considerable extent, as a pest of citrus, especially of limes. The white scale (*Chionaspis citri*) is of general distribution throughout the islands, and is to be seen on the trunks and branches of nearly every lime and other citrus tree, except in districts where the rainfall and general humidity are especially great. Other scale insects which are found on citrus trees, but have not become pests except in rare instances, are the red-spotted scale (*Chrysomphalus aonidum*), the red scale (*Chrysomphalus aurantii*), the chaff scale (*Parlatoria pergandei*) and the Lantana bug (*Orthezia insignis*).

THE PURPLE SCALE (*Lepidosaphes beckii*, Newm.).

This is an elongate insect, tapering from very narrow at the anterior to broad at the posterior end; the colour is light-brown or purplish. The female scale is larger and more tapering in outline than the male.

The purple scale (Fig. 82) which has long been known as a very serious pest of citrus trees in the West Indies, occurs on leaves and twigs. On the leaves, a number of these scales will generally be found grouped together on the under surface. The location of these groups is usually indicated by a yellowish, discoloured spot. On the twigs, these insects sometimes occur in such numbers as to form a

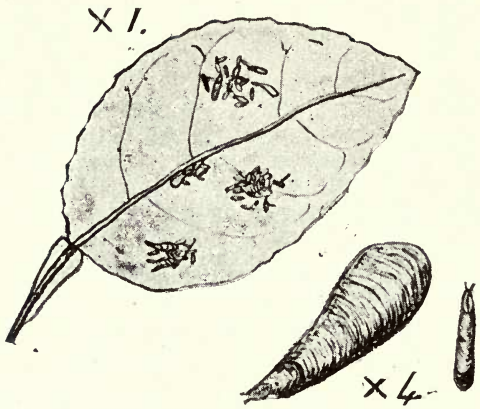

Fig. 82. Purple scale.
Enlarged. (*Imperial Dept. Agric.*)

layer several scales thick, or in other cases they may be scattered almost singly. This scale is attacked by lady-birds, parasitic Hymenoptera and parasitic fungi. The most active lady-birds in this connexion are small insects about the size of the head of a pin, or a trifle larger. These insects are of the typical lady-bird shape, dark-brown, black, or steely-blue in colour, and may often be seen walking about amongst the scales and feeding on them. The purple scale is attacked by two species of fungi, the red-headed fungus (*Sphaerostilbe coccophila*) and the white-headed fungus (*Ophionectria coccicola*). The former of these is well distributed throughout the West Indies and probably exerts a considerable degree of control over the purple scale. Ophionectria occurs in Dominica only. Parasitic Hymenoptera are fairly abundant throughout the West Indies. Scales which have been attacked by these insects can generally be distinguished by a small round hole through which the adult parasite has emerged.

THE ORANGE SNOW SCALE (*Chionaspis citri*, Comst.).

The orange snow scale (Fig. 83) is probably well known to all growers of citrus trees, occurring as it does in considerable numbers on the bark of the stem and branches of nearly all such plants. It often seems to form a distinct covering or layer over the bark. The female scale is pear-

shaped, of a greyish white colour, with a yellow spot at the narrow end. The male is smaller, of a clearer white colour, and is altogether more conspicuous than the female. The sides of the male are parallel, and there are three distinct longitudinal ridges. The yellow spot at the anterior end is present in the male, as in the female. It is not often the principal scale in any citrus cultivation, but it sometimes happens that this is the case, especially in dry situations, and it is then very destructive. Lady-birds and predaceous mites are often to be found associated with this scale, and it is likely that they, together with the parasitic Hymenoptera, very materially affect the abundance of the snow scale. There will often be seen patches, varying in size, of a black substance in the midst of the white scale on the bark of citrus trees. This is the black fungus (*Myriangium Duriaei*) which is parasitic on this scale, and exerts a great influence in keeping the pest in check.

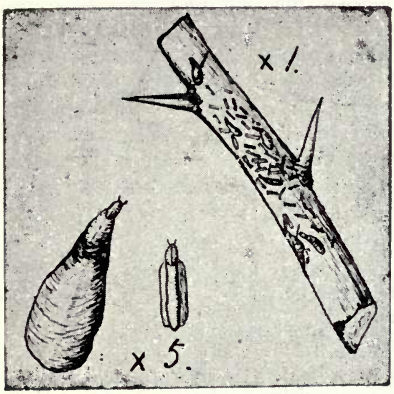

Fig. 83. Orange snow scale. *Enlarged.* (*Imperial Dept. Agric.*)

THE CHAFF SCALE (*Parlatoria pergandei*, Comst.).

The chaff scale takes its common name from the appearance of the scales on the bark. The straw-coloured female scales and the shrivelled males give to a colony of this insect a strong resemblance to chaff.

The chaff scale is of much more recent occurrence in these islands than either of the preceding. It is only recorded from limes in Montserrat, and this record dates from the end of 1910. The chaff scale has been known in Florida for some time, and it is there considered a pest of some importance. It is not known how far natural enemies may control this scale in the West Indies.

THE GREEN SCALE (*Coccus viridis*, Green).

The green scale is probably also of fairly recent introduction to the West Indies. It was identified in 1905, and has since been recorded from nearly all West Indian islands. It is a small, flat, green scale which occurs on the under side of the leaves of citrus trees, generally closely packed along the mid rib. It is also seen on the leaf petiole and on the tender twigs. Young limes are often severely attacked by the green scale, and this attack is usually followed by the purple scale. The cause of the diminution of the green scale after such an attack has not been determined, but it is probably some parasitic organism. The green scale is also controlled to a considerable extent by a parasitic fungus, the shield scale fungus (*Cephalosporium lecanii*).

THE RED-SPOTTED SCALE (*Chrysomphalus aonidum*, L.).

The red-spotted scale is a brownish or purplish scale insect with a circular outline, more convex than other scales on citrus. (Fig. 84.) The apex or central boss is

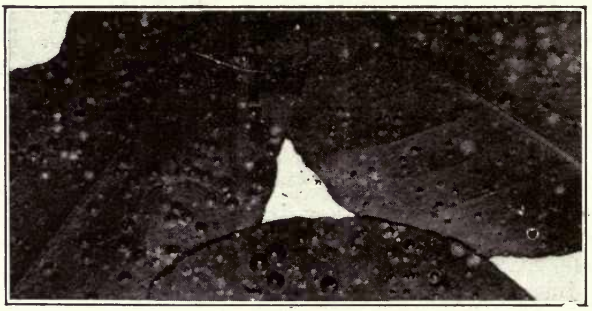

Fig. 84. Red-spotted scale.
Enlarged. (*Original.*)

reddish, and it is this feature that gives the common name to the insect. The red-spotted scale occurs on the under surface of the leaf. This insect is not often a serious pest, although it sometimes occurs in considerable numbers on nursery stock and young plants.

THE ORANGE RED SCALE (*Chrysomphalus aurantii*, Mask.).

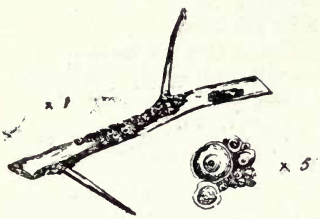

Fig 85. Orange red scale. *Enlarged.* (*Imperial Dept. Agric.*)

This scale is also circular in outline, but differs from the red-spotted scale in being less convex and of a lighter colour, and without the distinctive dark central boss. The scale covering is more delicate and more transparent also in the case of the red scale (Fig. 85).

The insect occurs on both leaves and twigs, often in sufficient numbers to cause the death of the tree.

THE LANTANA BUG (*Orthezia insignis*, Douglas).

Fig. 86. Lantana bug. *Enlarged.* (*Imperial Dept. Agric.*)

This is a black insect nearly covered with white wax; the back being partly naked, with two lines of white wax running lengthwise (Fig. 86). The body of the mature female terminates behind in an egg sac of white wax, which is curved up and may be as long as the insect itself.

Control. The scale insects which attack citrus plants in the West Indies are largely controlled by natural enemies. The effect of hymenopterous parasites, predaceous insects and mites, and of entomophagous fungi is very beneficial, and it is not as necessary to apply insecticides for the control of these pests as in many countries. If, however, the attack of scale becomes serious and shows no sign of decreasing in severity, spraying with any of the recognized contact insecticides will be found of value.

The spray mixtures containing rosin are useful for the purple, the red-spotted, the red, the chaff and the green scales, while whale-oil soap is best to use in connexion with the snow scale and the Lantana bug.

THE WHITE FLY (*Aleyrodes citri*, Riley and Howard).

The white fly is closely related to the scale insects, although they differ very much in appearance. The immature forms of Aleyrodes are similar to the scale insects, but in the adult stage both sexes are winged, with two pairs of wings covered with white, mealy wax.

The citrus white fly (*Aleyrodes citri*) is a very serious pest of citrus trees in Florida, but in the West Indies white fly attack on citrus trees has not been very severe. (Figs. 87 and 88.) White flies are found on citrus in the West

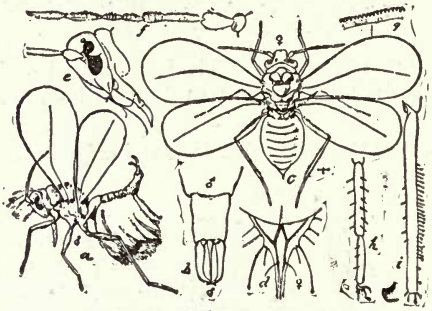

Fig. 87. Citrus white fly.

(a) winged male; (b) end of body, male; (c) winged female; (d, e, f, g, h, and i), structural details. (a) and (c) enlarged, others much enlarged. (From U.S. Dept. Agric.)

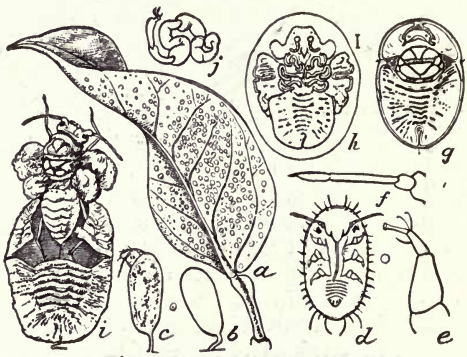

Fig. 88. Citrus white fly.

(a) orange leaf showing infestation on under surface, natural size; (b) egg; (c) same with young insect emerging; (d) larva; (e) foot of same; (f) larval antenna; (g) scale-like pupa; (h) pupa about to disclose adult insect; (i) insect escaping from pupal shell; (j) leg of newly emerged insect not yet straightened and hardened. All figures except (a) greatly enlarged. (From U.S. Dept. Agric.)

Indies, and these have been referred to as the citrus white fly, but there is some likelihood that a more careful study of these insects will demonstrate that the West Indian white fly is the same as a new species recently discovered in Florida, and which is much less serious as a pest than *Aleyrodes citri.* The new species referred to is *Aleyrodes nubifera,* Berger. Specimens of white fly fairly common in Barbados have recently been identified by the state entomologist of Florida as *Aleyrodes nubifera.* Another species (*A. howardi,* Quaintance) is also known to occur on citrus plants in the West Indies, and it may be one of the species found in the Lesser Antilles.

White fly is attacked by the red-headed fungus, *Sphaerostilbe coccophila,*) already mentioned, which occurs in the West Indies and in Florida, and also by several species of parasitic fungi. If it becomes necessary to spray for the control of white fly, a whale-oil soap solution will be found very effective.

BARK BORERS (*Leptostylus praemorsus*). Coleoptera.

Citrus trees are often attacked in the stem near the ground, and wherever, in pruning, stubs have been left which have decayed, by grubs which tunnel in the soft wood underneath the bark. These grubs are the larvae of long-horned bettles, one species of which has been identified as *Leptostylus praemorsus* (Fig. 89). The grub is whitish, with a small brown head, and very much flattened in appearance. The beetle is brownish with long slender antennae.

Fig. 89. Lime tree bark-borer.
About 1½ times natural size. (*Original.*)

It is probable that the eggs of the bark borer are laid only in dead or dying portions of the trees, but it is also likely that the grubs, by their feeding, very often increase the amount of dead wood and hasten the death of the tree.

Bark borers can often be located by the dead and shrunken patches of bark. They can be dug out with a knife and the wound thoroughly cleaned and tarred, or they may be killed by probing with a wire, or by the use of carbon bisulphide, injected into the tunnels of the borers.

Fig. 90. Orange bark weevil. (*Imperial Dept. Agric.*)

A small weevil of the genus Cryptorhynchus (Fig. 90) has been reported as a borer in the stems of orange trees in Grenada. This insect can hardly be called a pest, since its occurrence is comparatively rare. In the event of large cultivations of oranges being established, however, the possibility of a very rapid increase in the numbers of the borer should be kept in mind.

THE RUST MITE (*Phytoptus oleivorus*, Ashmead). Acarina.

The rust mite is not of very common occurrence in the West Indies. It is a small mite similar to the leaf-blister mite of cotton. It feeds on the skin of limes lemons and oranges, producing in the case of the latter a russet appearance, and in the case of limes and lemons a silvery appearance of the skin. Dry flowers of sulphur, used pure or with equal amounts of lime, is the remedy employed in Florida when it becomes necessary to control this mite by artificial means. This insecticide would probably be found satisfactory also in the West Indies; it is applied after rain, or in the early morning while the foliage is still wet, being broadcasted from the hand.

Bengal beans have been much used for the control of scale insects and the general improvement of lime trees in Montserrat. The beans were planted, about four to each tree, and allowed to grow and completely cover the trees. The accompanying illustration (Fig. 91) shows the appearance of a field covered in this manner.

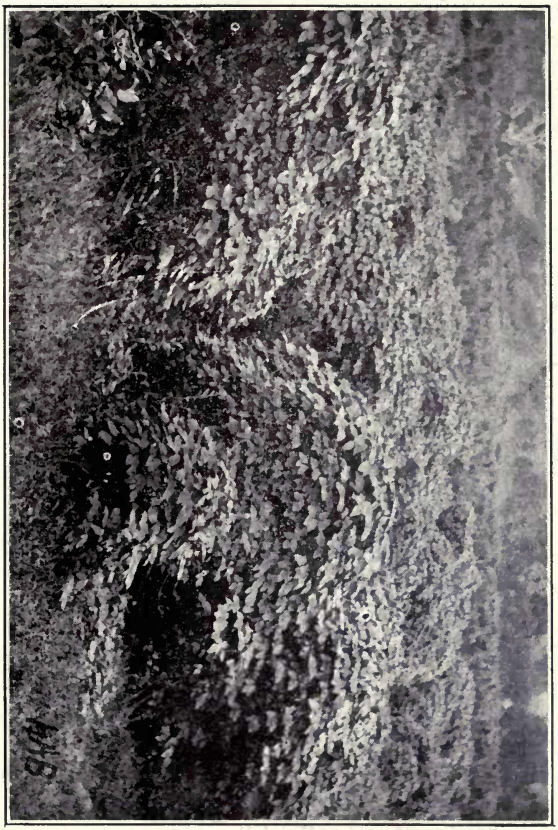

Fig. 91. Lime trees covered with Bengal Beans. (*Original.*)

Good results have been obtained in this way, but it is not known exactly what is the effect of the Bengal bean. Generally it is entirely beneficial and much more so than would be expected merely by the increase of the natural enemies, which has been supposed to be the chief result of the use of the Bengal beans.

In a few instances, in a wet season and in damp situations, harm seems to have resulted from too heavy a covering of Bengal beans.

In many parts of the world where citrus fruits are grown, fruit flies are very serious pests. These are Dipterous insects of several species, possessing very similar habits and life-histories.

In general, the eggs of the fruit flies are deposited in or on ripening fruits. The maggots, on hatching from the eggs, tunnel into the tissues of the fruit and cause it to drop and decay.

The Mediterranean fruit fly (*Ceratitis capitata*, Wied.)—Fig. 92—is perhaps the most widely distributed of

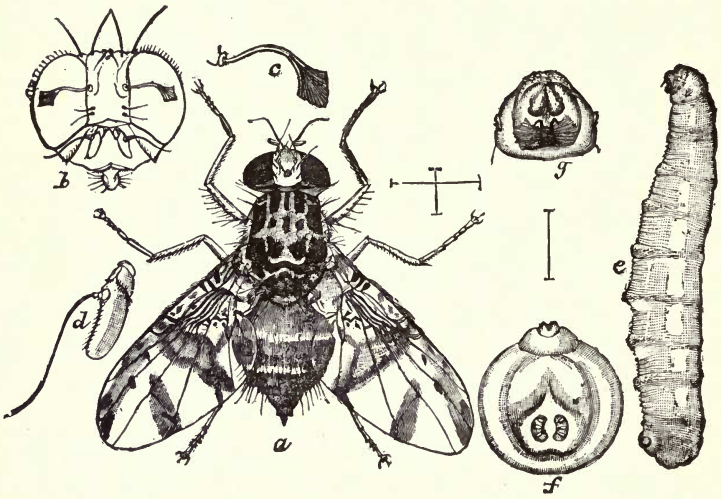

Fig. 92. Mediterranean fruit fly.
(*a*) *adult insect*; (*e*) *larva*; *other letters refer to structural details. All enlarged.* (*From U. S. Dept. Agric.*)

the fruit flies. The Mexican fruit fly or orange worm (*Trypeta ludens*, Loew)—Fig. 93—and *Dacus Tryoni*, Froggatt, of Australia, are also very serious pests.

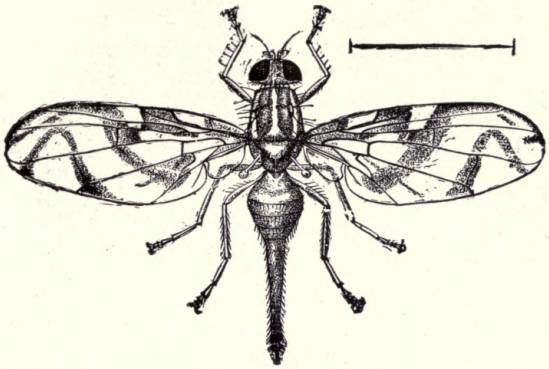

Fig. 93. Mexican fruit fly.
Adult female. Enlarged (*From U. S. Dept. Agric.*)

In the Lesser Antilles, citrus fruits do not seem to be attacked to any extent by fruit flies, although other fruits such as guavas and sapodillas are often found to be 'wormy' or infested with the maggot of a species of Anastrepha, one of which is *A. serpentina*, Wied.

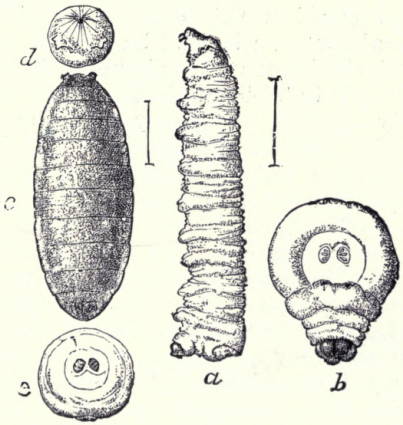

Fig. 94. Mexican fruit fly.
(*a*) *larva*; (*c*) *puparium*; (*b, d and e*) *structural details*
All enlarged (*From U. S. Dept. Agric.*)

CACAO.

THE CACAO BEETLE (*Steirastoma depressum*, L.). Coleoptera.

The cacao beetle (Fig. 95) is perhaps the most serious insect pest of cacao in the West Indies. The egg is laid in or on the bark, often in the angles formed by the larger branches. Stubs left in pruning, and any wound of a tree, seem to attract the egg-laying females. The grub reaches a length of about 1½ inches when it is full-grown. It is whitish in colour with a small, dark-brown head. The pupa is formed in the tunnel made by the larva. The adult is a black and grey beetle about ¾-inch in length, with long, slender antennae. The location of the grubs under the bark of the cacao tree is often indicated by a dry, shrunken appearance.

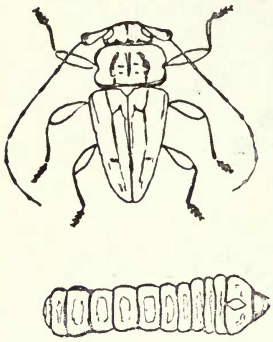

Fig. 95. Cacao beetle. *Adult and larva. Natural size.* (*Imperial Dept. Agric.*)

Control. The grubs of the cacao beetle may be dug out, or killed by probing with a wire. Carbon bisulphide may also be found useful in this connexion. When the beetle grubs are dealt with, all dead bark and wood should be removed and the healthy wood which is exposed should be tarred or painted. The adult beetles may be trapped. In the early morning they may often be found resting on the trunks and larger branches of the cacao trees where they may be collected, and killed by throwing them into water to which a small amount of kerosene has been added. In Surinam, the bark of the silk cotton tree is tied on to the cacao trees to furnish hiding places for these beetles. These hiding places are examined regularly and the beetles collected. In Trinidad, trap pieces of the Wild Chataigne or 'Chataigne Moron' (*Pachira aquatica*) have been found very useful. The freshly cut pieces of Chataigne which are placed in the cacao tree provide the female beetles with a suitable situation for egg laying, and the eggs are laid in the traps instead of in the cacao trees. In Grenada, branches which are removed from the trees in pruning are left on the ground for a few days.

These branches attract the egg-laying females, and are afterward collected and burned. It must always be remembered, however, that when traps of this sort are provided for insects, it is necessary that they should be disposed of before the insects have an opportunity to become mature, and escape. All wounds made in pruning are carefully tarred or painted, so that they shall offer no attraction as places for egg-laying.

CACAO THRIPS (*Heliothrips rubrocincta*, Giard.)
Thysanoptera.

Thrips are small insects which attack the leaves and pods of cacao, and sometimes occur in considerable numbers. The egg is deposited in the tissue of the plant by means of the saw-like ovipositer with which the female is provided. The adult insect is $\frac{1}{20}$-inch, or less in length, and has wings fringed with long delicate hairs. (Fig. 96).

Fig. 96. Cacao Thrips.
Adult insect. Enlarged. (Imperial Dept. Agric.)

The young (Fig. 97) is distinguished by a bright-red band across the abdomen. Cacao is injured by the feeding of the thrips, which have mouth parts adapted for piercing or cutting the surface and sucking the juice from the tender tissue beneath. Wherever these feeding wounds occur, a scar is produced. This is especially noticeable on the pods, a badly attacked pod being discoloured by this

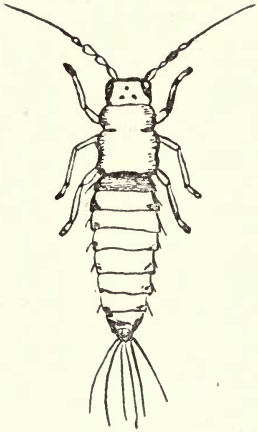

Fig. 97. Cacao Thrips.
Immature insect. Enlarged. (*Imperial Dept. Agric.*)

means to such an extent that unripe pods often appear ripe. The young, tender leaves of cacao are also attacked by thrips.

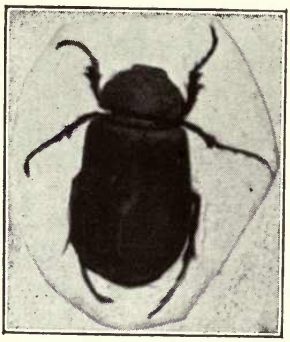

Fig. 98. Beetle which eats cacao leaves in St. Vincent.
Enlarged about $1\frac{1}{2}$ *times natural size.* (*Original.*)

Serious attacks of thrips seem to occur most generally when some condition of soil or climate is unfavourable, Careful attention to drainage, the application of manure. and the addition of humus to the soil will often be found quite satisfactory in dealing with this pest. If it becomes necessary to spray, rosin wash will be found effective.

Cacao is attacked by aphis, mealy-bugs and scale insects. These are not often serious pests. The aphis sometimes is seen in considerable numbers on the young tender leaves. Mealy-bugs often occur on the pods where two pods are touching, or where a pod rests against the bark of the stem. Aphis and mealy-bug may be controlled, if necessary, by spraying with kerosene emulsion or whale-oil soap solution. Cacao is not often attacked by scale insects, but this has happened in a few instances. In a mild attack scale insects could be controlled by spraying, but if a tree becomes thoroughly infested, it may be better to cut the plant down and burn it

The root borer of the sugar-cane has been reported as attacking cacao in St. Lucia, especially where the crop is growing on lands formerly devoted to sugar cultivation.

In St. Lucia and St. Vincent, beetles have been found from time to time eating the leaves of young cacao, and they have caused considerable damage. No satisfactory remedy for the root borer and the leaf-eating beetle attacking cacao has been discovered. One of these insects is shown in Fig. 98.

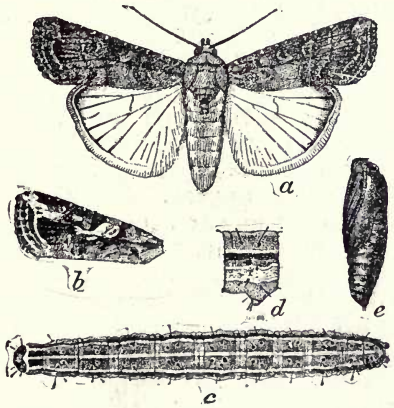

Fig. 99. Corn ear worm.

(a) Moth, grey form; (b) fore wing of the more ornamental form; (c) larva; (d) abdominal segment of larva, lateral view; (e) pupa lateral view; (d) twice natural size. Others enlarged one-fourth.
(From U. S. Dept. Agric.)

INDIAN CORN.

Indian corn is attacked by the moth borer (*Diatrae saccharalis*) in a manner very similar to that in which it affects sugar-cane.

The corn ear worm (*Laphygma frugiperda*, S. and A.) —Figs. 99 and 100—and the boll worm (*Heliothis obsoleta*, Hübn.), both of which have been mentioned as pests of cotton, attack the developing ears of corn, and often cause a very considerable amount of damage. The eggs of the boll worm are laid singly on the tassel and silk of the corn, and those of the corn ear worm on the leaves, in clusters. (Fig. 100.)

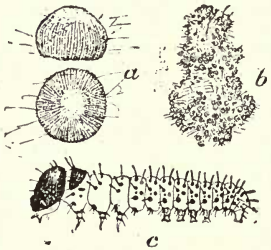

Fig. 100. Corn ear worm

(*a*) *Egg from side in upper figure, from above, in the lower,* (*b*) *egg cluster* (*c*) *newly hatched larva;* (*a*) *and* (*c*) *much enlarged,* (*b*) *somewhat enlarged.* (*From U. S. Dept. Agric.*)

If the caterpillars are present before the ears form, they begin feeding in the centre or throat of the plant. The injury to the young leaves is plainly to be seen when these have developed, in the irregular holes and ragged edges which so often appear. Later in the season the caterpillars attack the ears, entering at the silk end (Fig. 101). Here they eat the young, tender grain, sometimes destroying more than half the entire ear. The caterpillars of both these species are cannibals to a certain extent, for when two caterpillars come together in the course of their feeding, especially when in the ear, one is almost certain to kill and eat the other.

Both these insects have a very wide distribution throughout the West Indies. The boll worm is known in nearly all parts of the world, and the corn ear worm extends its range throughout the warmer parts of America.

Control. It is a common practice in the West Indies to drop a little fine dust or ashes into the throat

of a corn plant as soon as the first signs of attack are observed. Paris green and lime have been tried for this purpose, but they very often injure the leaves of the corn. A mixture of 1 teaspoonful of Paris green and 1 quart of corn meal has been found useful. A small quantity of this mixture is applied in the middle of the rolled-up leaves; it is eaten by the caterpillars and does not seem to injure the plant.

Fig. 101. Cotton boll worm.
Showing mode of attacking ear of corn. (*From U.S. Dept. Agric.*)

Early planting is said to be of advantage in this connexion, as in this case the corn is very rarely attacked to the same extent as when it is planted late.

Guinea corn is also attacked by small grey moths which infest the ripening heads of grain, sometimes completely spoiling them. This form of injury has been reported from Nevis in an experiment plot containing a very close-headed variety of Guinea corn. The only method of prevention in such a case as this would be the cultivation of a kind with a very open head.

ARROWROOT.

THE ARROWROOT WORM (*Calpodes ethlius*, Cramer). Lepidoptera.

The larva of this insect, which occurs throughout the American tropics, feeds on arrowroot and canna. The eggs are laid on the leaves of the food plant, and the larvae, as soon as hatched, begin feeding, protecting themselves from view in a fold of the leaf, which they make by drawing over the margin of the leaf and tying it down with a piece of silk. The caterpillars are greenish in colour, and very delicate in appearance. The skin is so thin that it is possible to distinguish a good deal of the internal anatomy. The caterpillar has a very peculiar appearance on account of the small neck which is characteristic of the insects of this group. The adult (Fig. 102) is brown in colour, with angular white spots in the wings, the under surface being lighter than the upper.

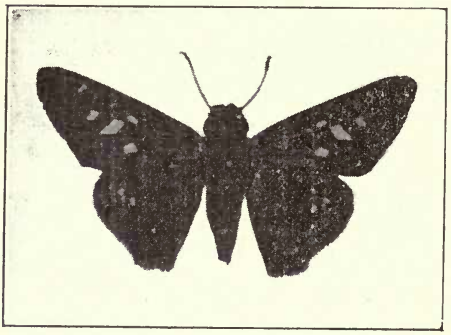

Fig. 102. Canna Moth.
Natural size. (*Original.*)

This insect belongs to a group of the Lepidoptera called skippers, which is intermediate between the butterflies and the moths. The most prominent characters of the group are the clubbed antennae terminating in a fine hook in the adult, and the broad head and small neck in the larva.

Control. The eggs of the arrowroot worm are parasitized by a minute hymenopteron (probably *Trichogramma pretiosa*), and it is likely that blackbirds, and the predaceous wasps, such as the wild bee and others attack the larvae.

Paris green, applied dry as for the cotton worm, will be found satisfactory for the control of this insect, when it occurs in sufficient abundance to render necessary the use of insecticides.

TOBACCO.

THE TOBACCO WORM (*Protoparce sexta*, Johanssen). Lepidoptera.

The leaves of the tobacco plant are often eaten by large green caterpillars, with oblique, whitish bands on the sides. The adult insect is a hawk moth, grey in colour with dark-brown or black lines marking wings and body. The spots, ranged in a row on each side of the abdomen, are yellow in colour. The northern tobacco worm (*Protoparce celeus*) shown in Fig. 103, is similar in general appearance to the West Indian species.

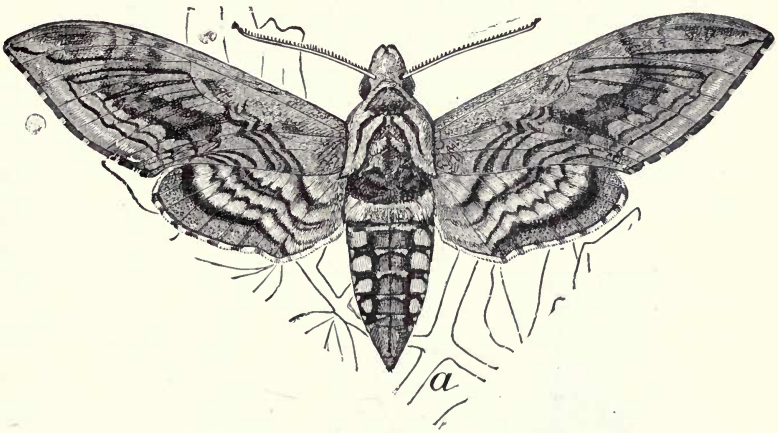

Fig. 103a. Northern tobacco worm.

Moth. Natural size. (*From U. S. Dept. Agric.*)

The female moth deposits the eggs singly on the leaves and other parts of the plant. The full-grown larva reaches a length of 2½ to 3 inches. The pupa is formed in the ground. The developing proboscis in its protective covering forms a sort of handle, which is a characteristic feature of insects of this group.

Control. The tobacco worm may be controlled by the use of Paris green or lead arsenate, the latter as a spray in water at the rate of 2 lb. in 50 gallons of water, or the former applied dry, in a mixture with lime at the rate of 1 lb. to 5 or 6 lb. of lime.

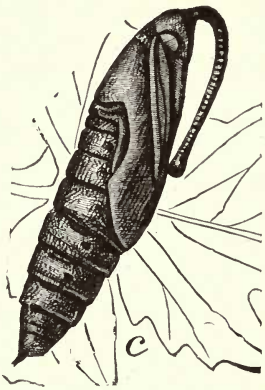

Fig. 103b. Northern tobacco worm.
Pupa. Natural size. (From U. S. Dept. Agric.)

Hand picking is very efficient, because the caterpillars are large enough to be easily seen, and this is not very expensive in localities where labour is fairly abundant.

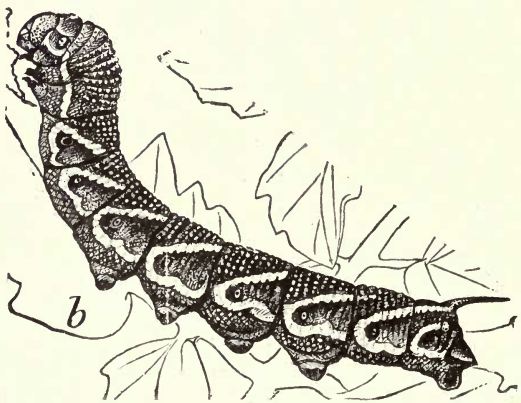

Fig. 103c. Northern tobacco worm.
Full-grown larva. Natural size. (From U. S. Dept. Agric.)

The natural enemies of the tobacco worm probably exert a strong influence on the abundance of this insect, although definite knowledge on this point seems to be lacking. The parasitic fly (*Sturmia distincta*, Wied.) is known to attack the potato worm, and is probably one of the natural enemies of the tobacco worm.

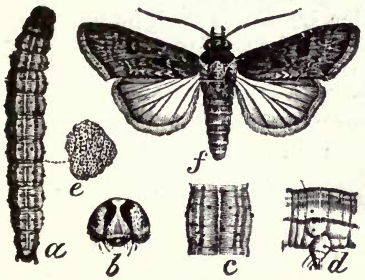

Fig. 104. Cut worm.
(*a*) *larva*; (*b*) *moth. Natural size.*
(*U. S. Dept. Agric.*)

CUT WORMS. Young tobacco plants are often destroyed by cut worms (see Fig. 104) soon after being planted in the field. These are the same as, or similar to, the insects mentioned in connexion with cotton and would be controlled in the tobacco field by the use of poison bait in the same manner as in the cotton field.

THE FLEA BEETLE (*Epitrix parvula*, Fabr.). Coleoptera.

The flea beetle (Fig. 105) is a small beetle with the hind legs adapted for jumping ; it is from its possession of

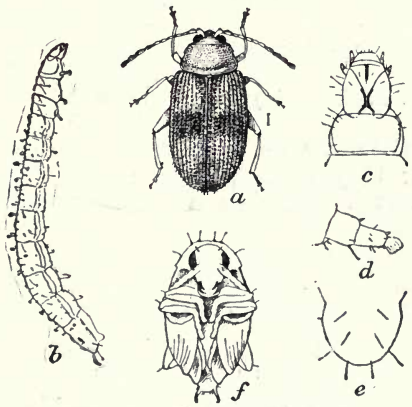

Fig. 105. Tobacco flea beetle.
(*a*) *beetle*; (*b*) *larva*; (*c*) *head of larva*; (*d*) *posterior leg of larva*; (*e*) *anal segment*; (*f*) *pupa.* (*a*) (*b*) *and* (*f*) *enlarged about 15 times*; (*c*) (*d*) *and* (*e*) *more enlarged.* (*From U. S. Dept. Agric.*)

the habit of jumping that the common name is derived The larvae and adults feed on the leaves, puncturing them with numerous minute holes.

In some localities tobacco is seriously affected by attacks of this insect, which by its feeding ruins the leaf, as far as its use for cigar-making is concerned. Spraying with Bordeaux mixture is sometimes very useful in controlling attacks of the flea beetle. It might happen, however, that the fine hairs on the surface of the leaf would hold the solid ingredients of the Bordeaux mixture to such an extent as to impair the value of the leaf if the application was made only shortly before the time of reaping. Lead arsenate is also useful in this connexion.

SWEET POTATOES.

THE SCARABEE OR JACOBS (*Cryptorhynchus batatae*, Waterhouse). Coleoptera.

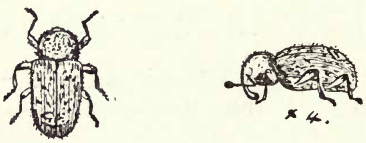

Fig. 106. Scarabee or Jacobs.
Adult insect. Enlarged.
(*Imperial Dept. Agric.*)

In the West Indies a small snout beetle and its grub often cause very serious loss to the growers of sweet potatoes. This insect (Fig. 106) is commonly known in Barbados as the Scarabee, and in the Northern Islands as Jacobs. The entire life of the scarabee is passed on or in the potato. The grub (Fig. 107) is small, whitish and without distinct legs, somewhat resembling a maggot, which tunnels

Fig. 107. Scarabee or Jacobs.
Larva. Enlarged. (*Imperial Dept. Agric.*)

through the tissues of the potato. (Fig. 108.) Whenever it is attacked in this manner the potato acquires a disagreeable odour and will not be eaten by stock.

Fig. 108. Sweet potato attacked by Scarabee.
Reduced. (Original.)

The eggs are laid in the potato, the grubs and pupae (Fig. 109) occur there, and the adult beetles mate when they emerge and the female deposits eggs in the

Fig. 109. Scarabee or Jacobs.
Pupa. Enlarged. (Imperial Dept. Agric.)

same potato. The first attack on a potato may result in a slight infestation at one end—the end nearest the surface of the ground. The generation of adult beetles from this first attack spreads to a larger portion, and it may happen that the attack of a third generation can be traced in the potato. The life-history of the scarabee occupies a period of about thirty days. The grubs sometimes occur in the older portions of the stem just above the roots.

Control. The scarabee is a difficult pest to control. When the attack has once begun, there is no way of reaching the insect with any insecticide. Care should be taken to plant only strong, healthy slips, which are free from scarabee, and the potatoes should be dug as soon as they are ripe. Potato slips for planting may be produced in a nursery established for the purpose. Small potato roots and pickings are taken from a field after a crop is harvested, and planted in some favourable location, away from potato fields. The roots and pickings used for this purpose should be carefully examined, and any that show signs of scarabee attack should be rejected. If such a nursery is maintained for only six or eight months, it is not likely to become sufficiently infested for the vines to be attacked. As soon as any attack of scarabee is noticed in the nursery it should be abandoned and a new one established.

THE SWEET POTATO WORM (*Protoparce cingulata*, Fabr.). Lepidoptera.

The leaves of the sweet potato are often eaten by a large green caterpillar (Fig. 110) which sometimes occurs in

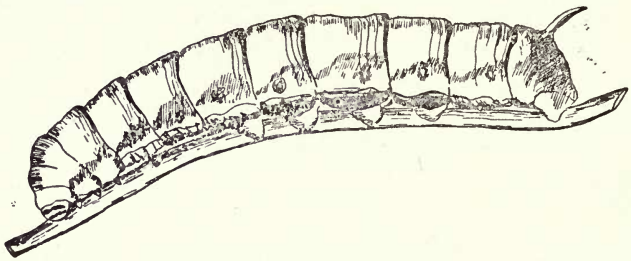

Fig. 110. Potato worm.
About natural size. (*Imperial Dept. Agric.*)

such enormous numbers as to eat all of them, leaving only the bare vines in the field. This is the larva of the sweet potato hawk moth. This caterpillar when full-grown

Fig. 111. Potato worm.
Pupa. About natural size. (*Imperial Dept. Agric.*)

reaches a length of about 3 inches. The pupal stage (Fig. 111) is passed in the ground, and lasts some ten or twelve days. The moths (Fig. 112) have a spread of wings of about

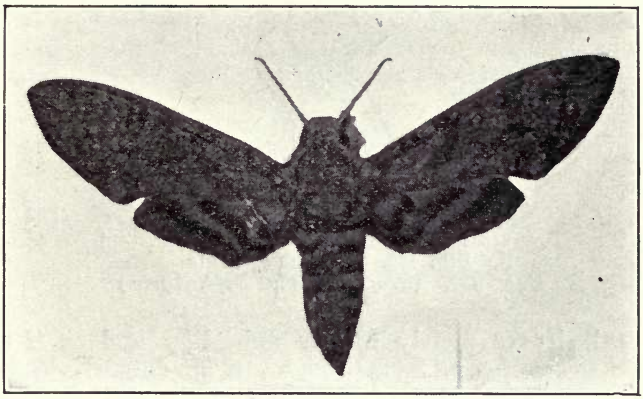

Fig. 112. Potato worm.
Adult insect. Natural size. (*Imperial Dept. Agric.*)

3 inches, and the body is about $1\frac{3}{4}$ inches in length. This is one of the most abundant of the large moths, in Barbados at least, and is often attracted to lights in houses. The moth is greyish or brownish in colour, with five pairs of pinkish or reddish spots along the abdomen.

Control. It only rarely happens that this insect occurs in such numbers as to make it necessary to apply any insecticide for its control. When this occurs, however, Paris green and lime will be found a thoroughly efficient remedy.

The caterpillars of the sweet potato worm are attacked by a parasitic fly (*Sturmia distincta*). These parasitic flies (Fig. 113) finish their development in the pupa of the potato moth, and it often happens that in fields where countless numbers of worms have entered the soil to pupate, very few moths emerge. Egg parasites are known as natural enemies of many moths, and it is likely that the eggs of this insect are also attacked in this manner.

The leaves of sweet potato vines are often seen to be injured when no apparent cause is noticeable. The injury due to the ravages of the caterpillar are plainly to be seen, and there is no doubt as to the cause of the injury; but

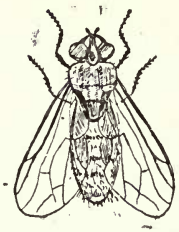

Fig. 113. Sturmina distincta.
Enlarged. (*From Imperial Dept. Agric.*)

when the leaves merely appear unhealthy and as if the plants were suffering from drought, more careful observation is required to enable the planter to distinguish exactly the nature of the trouble. Thrips, flea beetle and red spider, any one or all of these, produce an unhealthy appearance of the leaves, when the minute size of the pests renders it difficult to distinguish them.

THE FLEA BEETLE (*Chaetocnema amazona*, Boky). Coleoptera.

This is a very small, steely blue beetle with legs well developed for jumping. When disturbed the insects jump from the surface of the leaf on which they are feeding and take flight. This habit makes the flea beetle rather difficult to observe. The adult beetles feed on the leaves, causing them to show small patches where the tissues are dry or discoloured. The feeding habits of the larvae do not seem to be known.

THRIPS (*Euthrips insularis*, Franklin). Thysanoptera.

Thrips live on the under side of the leaves of the sweet potato. Several species of these insects are found on this and related plants; the most abundant seems to be the one named above. Their peculiar feeding habit

result in injuries to the leaf which cause it to curl slightly and to show all over the surface fine streaks of a light colour.

RED SPIDER (*Tetranychus telarius*, L.) Acarina.

Red spider (Fig. 114) also lives on the under surface of the leaves, and, when very abundant, on the upper surface as well. The red spider forms a very fine web under which

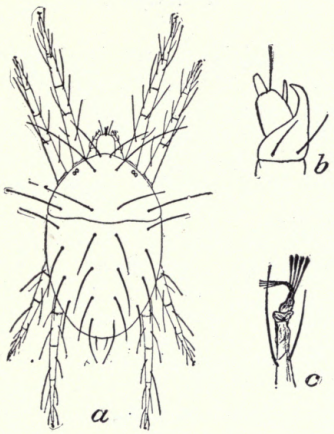

Fig. 114. **A red spider.**
(*a*) *adult*; (*b*) *palpus*; (*c*) *claw. Enlarged.* (*From U. S. Dept. Agric.*)

most of the mites live. The feeding of these mites results in a considerable amount of curling of the leaves, and in producing a russet appearance on leaf-stalk and vine.

Thrips and red spiders are both very small in size, but they can be easily distinguished. Thrips are long and narrow; they never have more than six legs, and the adults are winged. The red spider has a comparatively short and broad body. The adults possess eight legs, and are never winged. The presence of a web is also an indication of the presence of red spider.

Control. Flea beetle does not often occur in such numbers as to require the application of insecticides The use of Paris green and lime, or lead arsenate

would give good results in controlling the pest. Thrips and red spider may both be controlled by one or two applications of sulphur and lime applied dry, as a dust, and it is likely that this would also have a useful effect in connexion with the flea beetle. These pests are more injurious in dry weather, and the adventof rains will often cause great reduction in their numbers.

THE SWEET POTATO WEEVIL (*Cylas formicarius*, Fabr.). Coleoptera.

This insect, which occurs in the southern United States, Jamaica and British Guiana does not seem to be known at preseut in the Lesser Antilles, although it is reported as having occurred formerly in Barbados. It is widely distributed throughout the tropics of the world. It attacks sweet potatoes in a manner somewhat similar to the scarabee; but the appearance of the insect is quite different, as will be seen by reference to the illustration (Fig. 115). This insect is mentioned here in order that planters throughout the West Indies may be able to identify the pest if it should appear.

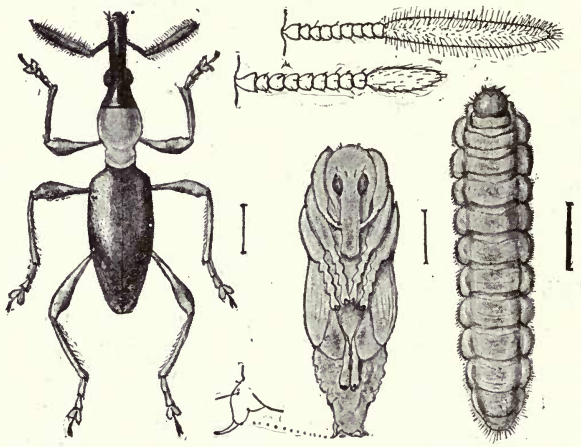

Fig. 115. Sweet potato weevil.
Larva; pupa; and adult. Enlarged. (From U. S. Dept. Agric.)

COCOA-NUTS.

SCALE INSECTS AND WHITE FLY. Hemiptera.

Cocoa-nuts are attacked by scale insects, which are to be found most abundantly on the older leaves. The most important of these is probably the Bourbon Aspidiotus (*Aspidiotus destructor*, Sign.) This is a small insect, the scale covering of which is thin and papery, with a pale yellow central spot (Fig. 116). Enormous numbers of this

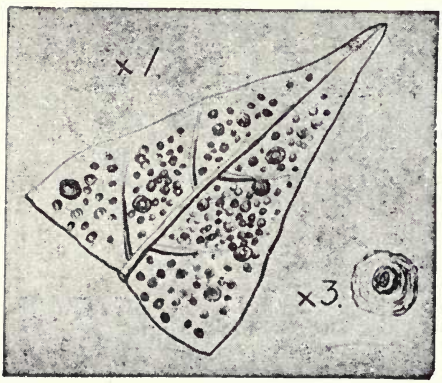

Fig. 116. Bourbon aspidiotus.
Enlarged. (*Imperial Dept. Agric.*)

insect are often found very closely crowded together; badly attacked leaves often have a yellowish or dried-up appearance.

This scale insect is attacked to some extent by lady-birds, and is probably parasitized by hymenopterous parasitic insects; but the extent to which this occurs and the species which are concerned in it do not seem to be recorded. In Cuba, the Bourbon Aspidiotus on cocoa-nuts is effectively controlled by the spotted lady-bird (*Chilocorus cacti*).

The cocoa-nut snow scale (*Diaspis boisduvalii*, Sign.) —Fig. 117—also occurs on the leaves, causing yellowish spots. The colonies are generally small; the female scale is pear-shaped, and similar in colour to the leaf, while the

male is oblong in shape and white in colour, with three distinct longitudinal ridges.

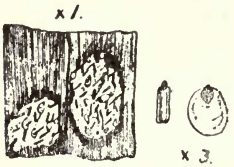

Fig. 117. Cocoa-nut snow scale.

Fig. 118. Cocoa-nut mealy-bug.
Enlarged. (Imperial Dept. Agric.)

The cocoa-nut mealy bug (*Pseudococcus nipae*, Mask.) is a small, round insect (Fig. 118) covered with yellowish wax, which occurs on the leaves, generally in small numbers, and not grouped into dense masses or colonies.

The glassy star scale (*Vinsonia stellifera*, Westw.) can easily be distinguished by the projections of wax in the form of a star, from which the insect gets its name (Fig. 119). This insect does not often occur in sufficient numbers on cocoa-nuts to become a pest.

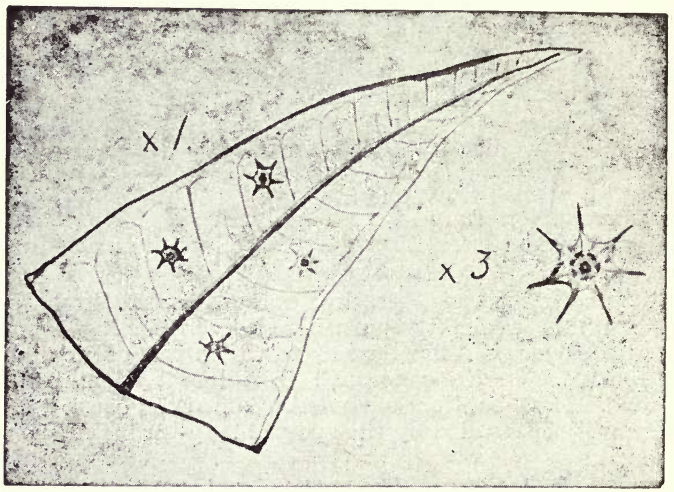

Fig. 119. Glassy star scale.
Enlarged. (Imperial Dept. Agric.)

The black line scale (*Ischnaspis longirostris*, Sign.) generally occurs on old leaves and on the fruit (Fig. 120). It is not a serious pest of cocoa-nuts, but often occurs in great numbers on other palms. It takes its common name from its black colour and its long, narrow shape.

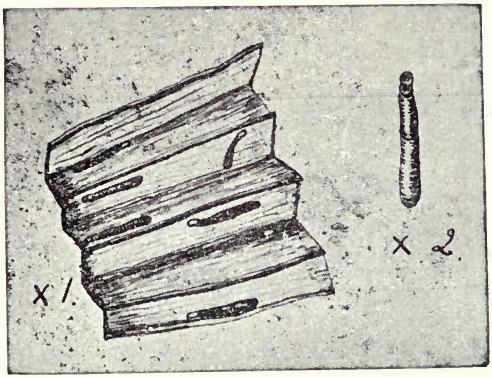

Fig. 120. Black line scale.
Enlarged. (*Imperial Dept. Agric.*)

The cocoa-nut white fly (*Aleyrodicus cocois*, Curtis) occurs as a serious pest of cocoa-nuts in many parts of tropical America. In Barbados, it has been considered largely responsible for the decrease in the number of cocoa-nut trees on the leeward side of the island. It is often to be found associated with the scale insects

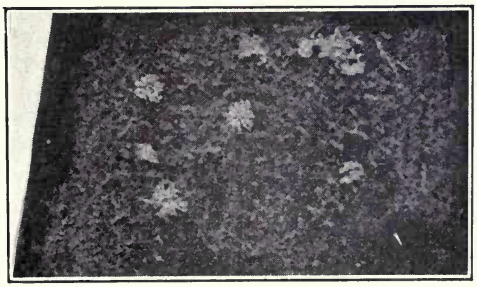

Fig. 121. Cocoa-nut white fly.
Immature insects, and white wax on palm leaf. Enlarged 1½ times natural size. (*Original.*)

already mentioned. It occurs in the same position, that is on the older leaves, as the Bourbon Aspidiotus.

The white fly colonies are distinguished by the presence of fine wax filaments, among which may be seen the immature stages (Fig. 121) which resemble scale insects, and also the winged adult (Fig. 122). These are delicate little insects with broad wings covered with a fine dust of wax, resembling flour.

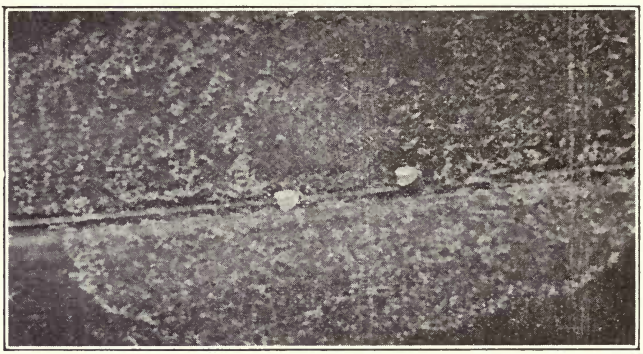

Fig. 122. Cocoa-nut white fly.
Adult insects and white wax on palm leaf. Enlarged 1½ times natural size. (Original.)

Control. If scale insects and white fly should occur on young cocoa-nuts in sufficient numbers to render the adoption of remedial measures necessary, these insects could be well controlled by spraying with whale-oil soap or some other oily or soapy spray material. In the case of older trees it might be advisable to remove the badly infested leaves and burn them. Both the Bourbon Aspidiotus and the cocoa-nut white fly occur on other plants, and where such plants are found harbouring these pests near cocoa-nut cultivations they should be removed.

Natural Enemies. Scale insects in the West Indies are more or less held in check by their natural enemies, and it is likely that this is true of the white fly. These are both parasites and predators, the former including parasitic Hymenoptera and fungi, and the latter the lady birds, and lace wing flies.

PALM WEEVIL (*Rhynchophorus palmarum*, L.). Coleoptera.

This is one of the largest of the weevils, being about 1½ inches in length, and broad in proportion (Fig. 123). Its larva is well known in some parts of the West Indies as the gru-gru worm. The gru-gru worm occurs as a borer in several different species of palm trees, and in some places is known as a pest in sugar-cane.

Fig. 123. Palm Weevil.
Enlarged 1½ times natural size. (Original.)

The adult female weevil deposits eggs within the tissue of the food plant. By means of the strong mandibles situated at the tip of the long snout, a deep incision is made in which the eggs are placed. The larva spends its entire existence as a borer, and when full-grown, changes to a pupa

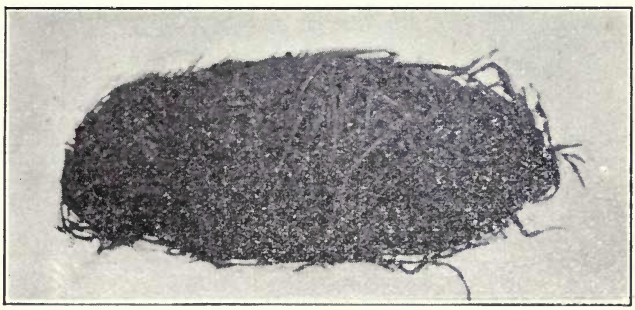

Fig. 124. Cocoon of Palm Weevil.
Slightly reduced. (Original.)

enclosed in a rough cocoon constructed of fibres of the food plant (Fig. 124), without leaving the host plant.

Control. The control of this insect is difficult when the borers have become established within the tissues of the plant. The adult weevils may, however, be very successfully trapped. The stem or trunk of any of the palms commonly attacked (cocoa-nut, gru-gru, etc.), if cut and left lying on the ground, will attract the egg-laying weevils. Pieces of the palm stems can be distributed through a cocoa-nut cultivation where the weevils are numerous, and examined from time to time for a few weeks until they are found to contain the borers, when they should be destroyed. It must be borne in mind, however, that any palms which have died and are left standing will offer the same attractions to the weevils as the trap pieces on the ground. All such trees should be promptly cut down as soon as they are found to be dead. If they are not already infested they may be used as traps. It is of the greatest importance that all trap logs and all dead and decaying trees of the kinds attacked by this insect should be completely destroyed at intervals of two or three months, so that the larvae in them should not have sufficient time to mature and emerge as adult weevils.

The larger moth borer of sugar-cane (*Castnia licus*,

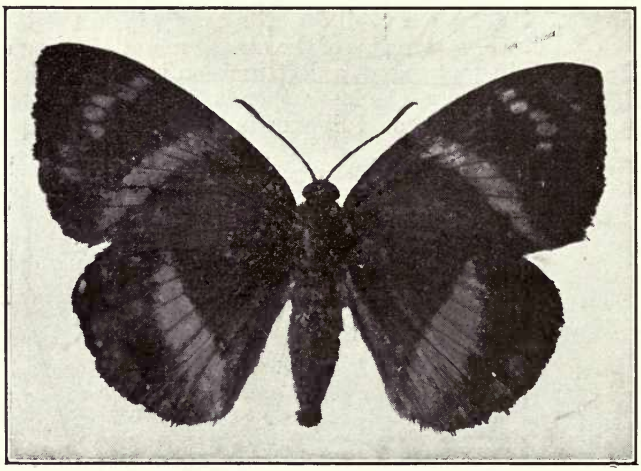

Fig. 125. Larger moth borer.
(*Original.*)

Drury) is reported as attacking cocoa-nuts in Trinidad (Fig. 125), and a related species (*C. daedalus*), causes similar damage in Surinam.

Leaf-eating caterpillars are known to attack cocoa-nut palms in certain localities. In British Guiana, *Brassolis sophorae*, and in Panama, *B. isthmia* occur. These are related lepidopterous insects, the caterpillars of which feed on the leaves of the cocoa-nut. They form large nests by tying leaves together. In these nests the caterpillars, sometimes several hundred in a single nest, live and feed.

These lepidopterous insects do not at present occur in the smaller islands of the Lesser Antilles, and every precaution should be observed to prevent their introduction. If they should occur, they might be controlled by spraying with arsenate of lead or Paris green, or the nests might be cut out and the insects destroyed by burning or crushing.

RUBBER.

The several species of rubber-producing plants cultivated in the Lesser Antilles are subject to the attacks of scale insects. Para rubber (*Hevea brasiliensis*) is less liable to these attacks than the others. Castilloa is attacked by the Akee fringed scale (*Asterolecanium pustulans*, Ckll.) especially when it is growing in unfavourable situations. Severe attacks of this scale (Fig. 126) on the stems of young Castilloa

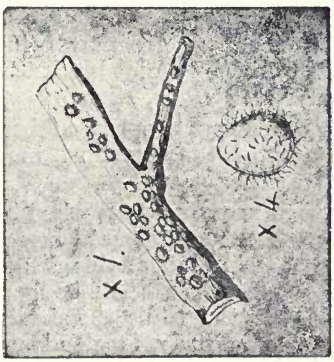

Fig. 126. Akee-fringed scale.
Enlarged. (*Imperial Dept. Agric.*)

plants result in checking the growth of the plant and producing a very unhealthy tree.

The Castilloa tree sheds its leaves at intervals and on this account scale insects which attack the leaves are not injurious to the same extent as those which attack the stem. The common mealy-bug (*Pseudococcus citri*, Risso) is very commonly found (Fig. 127), and sometimes in extreme

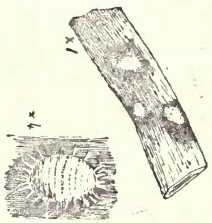

Fig. 127. The common mealy bug.
Enlarged. (*Imperial Dept. Agric.*)

abundance, on leaves of Castilloa. The appearance of trees attacked in this manner is very unsightly, because this mealy-bug is accompanied by black blight; but the injury resulting from such attacks is not often very great. As has been indicated, the leaves of the Castilloa fall to the ground and carry the mealy-bugs with them, and also these insects are often parasitized to a very considerable extent.

Funtumia rubber is very liable to attacks by the green shield scale (*Coccus viridis*, Green). The Ceara rubber, of which a few trial specimens are now being grown in the West Indies, are attacked by a flat black shield scale which may prove to be *Saissetia nigra*, Nietn.

If it becomes necessary to spray rubber for the control of scale insects, any of the standard insecticides would probably be found satisfactory.

Castilloa rubber is sometimes attacked by a borer which is the larva of one of the long-horned beetles. Very little seems to be known of the habits of this insect. It has been identified as *Taeniotes scalaris*. The body of the beetle is about $1\frac{1}{2}$ inches in length, while the slender antennae are considerably longer. The body is slender, and is distinguished by a broad white stripe extending from the head to the end of the wing covers. The wing covers are marked by alternating white and black lines.

Whenever the larvae of this insect occur as borers in Castilloa they should be cut out with a sharp knife, or killed by probing into their tunnels with a stiff wire.

NUTMEGS.

Nutmegs are commonly attacked by the mealy shield scale (*Pulvinaria pyriformis*, Ckll.), which occurs on the under side of the leaves, but does not often become a serious pest. When young, the scales are very flat, green in colour, rounded or ovate in outline (Fig. 128). The older scales are brown, and the eggs are laid in a mass of white cottony

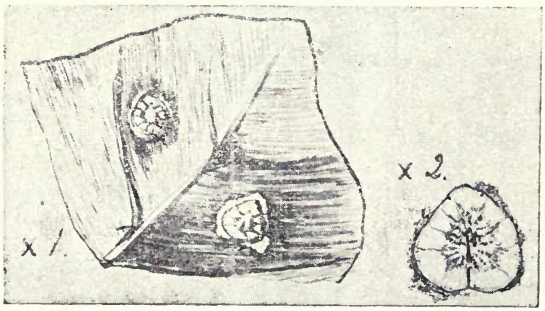

Fig. 128. Mealy shield scale.
Enlarged. (*Imperial Dept. Agric.*)

wax which raises one edge of the scale from the leaf, and protrudes slightly. If it is found necessary to spray for the control of this insect, any of the oily or soapy washes will give satisfaction.

BANANAS.

Bananas are attacked by at least two species of white fly, the more important of these being the white fly of the palms (see Figs. 121 and 122), which occurs sometimes in considerable numbers on the leaves of banana plants. It does not often happen, however, that spraying is necessary, for the removal of the old plants after the ripening of the fruit serves to destroy a large number of the insects.

In certain islands, bananas are subject to attacks of the larva of a beetle which bores into the underground

portions of the plant. This beetle is *Tomarus bituberculatus*, Beaud.—a large, shiny, black beetle of the typical hard-back form (Fig. 129). Perhaps the only satisfactory remedy is to dig out affected plants as soon as dis-

Fig. 129. Banana borer.
About 1½ times natural size. (*Original.*)

covered, and destroy the beetle grubs, taking care before replanting the hole that all grubs in the soil have been destroyed.

Bananas are also attacked by a small weevil borer (*Sphenophorus sordidus*, German), which is closely related to the weevil borer of the sugar-cane, but is rather smaller and of a more uniform dark colour than that insect. In Trinidad, the larva of the giant moth borer (*Castnia licus*) is known as a borer in the stem of banana plants.

YAMS.

The roots of yams will often be seen to be more or less covered with a small whitish or greyish scale insect (Fig. 130). This is *Aspidiotus hartii*, Ckll. Under ordinary circumstances, this scale does very little damage. An abundance of these insects probably hastens the drying up of the roots and increases the shrivelled appearance. Scale infested roots should not be

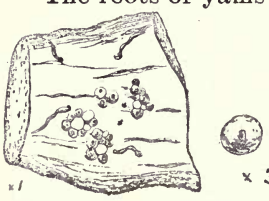

Fig. 130. Yam scale.
Enlarged. (*Imperial Dept. Agric.*)

used for planting. Scale insects on stored yams may be killed by the use of carbon bisulphide.

BEANS.

Beans, bonavist, woolly pyrol and other related leguminous plants are subject to attacks of leaf-eating caterpillars and red spider.

Woolly pyrol used as a green dressing is often completely eaten down by the larvae of the woolly pyrol moth (*Thermesia gemmatalis*, Hübn.). The only practical remedy seems to be early planting, in order that the crop may be well grown before the attack becomes severe, in August and September. If the caterpillars become exceedingly abundant, it would probably be wise to cut the woolly pyrol and turn it in, rather than allow it to be eaten down. Arsenical poisons are of very little use in dealing with the leaf-eating insects on leguminous plants, since they very often cause as much injury to the leaves as that brought about by the insects. The

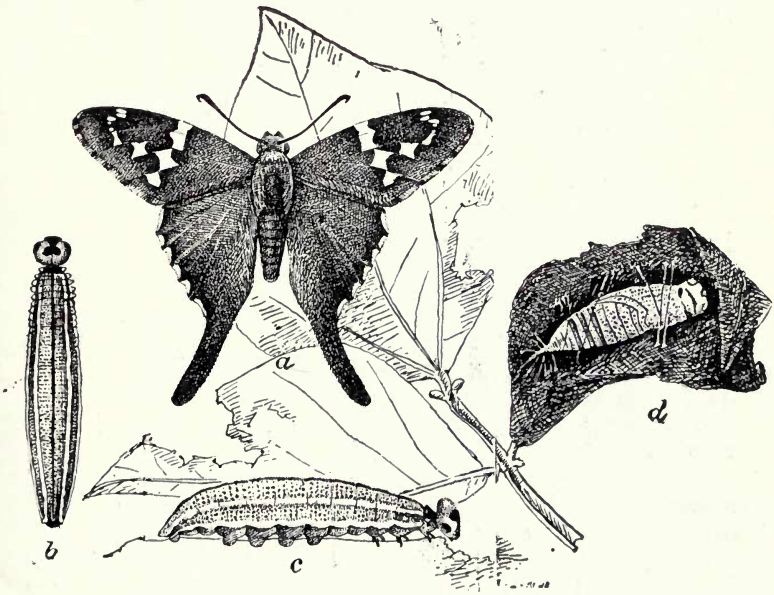

Fig. 131. The bean leaf-roller.
Natural size. (*From U. S. Dept. Agric.*)

bean leaf-roller (*Eudamus proteus*, L.) attacks several varieties of beans. The caterpillar of this insect folds over an edge of leaf to form a hiding place for itself. It is distinguished by its large head and a very small neck, and the yellowish and green colour of its body (Fig. 131.)

The bean leaf-roller never becomes very numerous, on account of the extent to which it is parasitized by a small hymenopterous insect, *Urogaster leucostigma*, Ashm. The eggs of this insect are laid in the body of the caterpillar, where they hatch and produce young grubs which feed on the tissues of the caterpillar. When fully grown these parasitic grubs penetrate the skin of the caterpillar and form a mass of white, silky cocoons. Sometimes, these grubs are so numerous that the mass of their cocoons completely hides the caterpillar from view. This insect furnishes an execellent example of parasitism, and it would be well worth the while of any planter or other reader of this pamphlet to collect a few of these caterpillars and feed them in a glass covered with muslin of order to have the opportunity of observing this example in nature's method of preserving a balance among the various forms of life.

MISCELLANEOUS PLANTS AND PESTS.

In addition to the plants which are grown in the West Indies as field crops, there are many others which are cultivated in the kitchen garden, and in pots and beds as ornamental and flowering plants. These are subject to insect attack, perhaps to even a greater degree than field crops grown under estate conditions ; and anyone who has attempted gardening must have been amazed at the number of pests to be combated, if he has taken notice of them. Most persons however merely attribute the death or unhealthy appearance of plants to blight, or worms, and never attempt any further classification of the organisms operating to bring about the undesired results.

Plant lice, leaf hoppers, white fly, scale insects and mealy-bugs occur on a great variety of food plants. They are all insects with sucking mouth parts and would best be controlled by contact poisons. Thrips and red spider also are of frequent occurrence ; while leaf-eating caterpillars, grubs in the soil, borers in stems and roots, mole crickets, cut worms, leaf-cutting bees, ants and nematodes

or eel worms all conspire against the gardener and constantly remind him that eternal vigilance is the price of liberty.

CUCUMBERS.

Cucumbers, melons, squash and other related plants are subject to the attacks of a variety of insect pests. The green fly (*Aphis gossypii*, Glover) often infests the leaves to such an extent as to dwarf the plant, if not entirely kill it. The young plants are often attacked by cut worms and the leaves and stems are severely injured by the caterpillars of the melon moth (*Diaphania hyalinata*, L.). The pale-green larvae of this very pretty little moth (Fig. 132) are often to be seen on

Fig. 132. Melon caterpillar.
Moths, larvae, and pupa. Natural size. (From U. S. Dept. Agric.)

the under side of the leaves of these plants. They feed on the tissues of the leaf between the veins, but they generally do not eat through the upper epidermis. The result is that an attacked leaf shows a number of dry, thin spots before the leaf wilts and entirely dries up.

These plants are not easy to protect from the attacks of the insects just mentioned, because of their susceptibility to injury by insecticides. Dilute whale-oil soap or tobacco solutions may be used as a spray, while wood-ashes, soot and very light dressings of lime may be found useful applied in the form of dust.

The plants in this group are also frequently severely attacked by nematodes or eel worms. These are minute, or almost microscopic, white worms which live in the soil and penetrate the tissues of the roots of plants of many kinds, producing swellings and deformities.

The effects of nematode attacks are most noticeable in gardens, but it is likely also that these pests cause very considerable losses on estates.

The remedies consist of clean cultivation, rotation of crops, and the free use of lime in the interval between crops. Once the worms have penetrated into the root tissues, they are protected from insecticides to a very large extent. The use of solutions of whale-oil soap, applied to the soil about the roots, will often check the increase of these pests sufficiently to allow a useful plant a longer life than if they are allowed to go unchecked.

Carbon bisulphide and a solution of potassium cyanide are also useful for this purpose.

Tomatoes and peppers are attacked by large green caterpillars, similar in size and general appearance to the potato and tobacco worms. These plants are also often infested with white fly, scale insects and mealy-bug. The egg plant, or garden egg is related to the tomato and pepper, and is often infested by the same pests. A very delicate hemipterous insect which is fairly common on the egg plant is the lace bug. The wings of this insect are membranous, very thin in texture, with numerous strong nerves or veins, presenting the appearance of a delicate pattern in lace.

Onions are attacked by thrips, which destroy the epidermis of the leaves and seriously interfere with the growth of the plants. Cutworms also prey upon onions, severing the young plants near the surface of the soil, or later climbing up to feed on the leaves at night and returning to hide through the day in the soil at the base of the plant, where they may often be found and destroyed. Caterpillars are sometimes found hiding inside the hollow leaf of the onion, where they feed until the

leaf is nearly dead. They enter at the base of the leaf by a small hole which they make by eating away the tissues. These holes are not easily seen and often the caterpillar remains hidden, destroying many leaves, perhaps several plants, before the real nature of the injury is discovered.

The mole cricket is a general pest living mostly underground, where it constructs tunnels near the surface, eating off all roots which come in its way. There are several species of mole crickets in the West Indies, but they are similar in general appearance and in habit. The one shown in the illustration (Fig. 133) is *Gryllotalpa didactyla.*

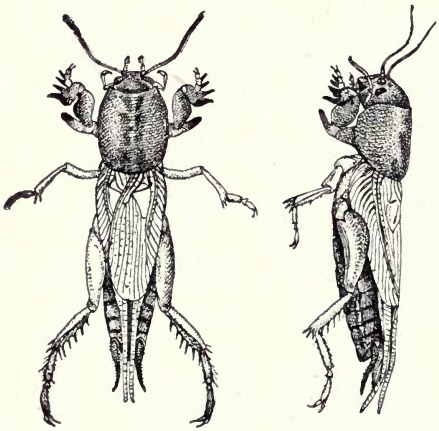

Fig. 133. Mole cricket.
Seen from above and from the side. (From U. S. Dept. Agric.)

These insects are pests in the garden, and especially in lawns. In the latter situations they completely kill the grass over considerable areas. They often come above ground at night, and may be destroyed by the use of a poison bait, or trapped in tobacco tins, containing a small amount of water, sunk in the soil with the top rim level with the surface of the soil, where they are numerous. The insects fall into the water, and being unable to climb out may be removed and killed in the morning.

Ferns are subject to attacks of thrips and mealy-bug, and certain species are also attacked by scale insects. Palms are often seen more or less badly attacked by scale insects; crotons (*Codiaeum* spp.), by mealy-bug and borers.

The leaves of palms are, in general, tough, and fairly strong insecticides may be used without injury to them. Whale-oil soap, 1 lb. to 3 or 4 gallons of water, or kerosene emulsion, used as a spray or applied with a sponge or cloth, will give good results in the treatment of most scales on palms.

Ferns are more delicate, and care must be exercised in applying insecticides to them. A solution of whale-oil soap, 1 lb. to 5 or 6 gallons of water, applied in a very fine spray, should be sufficient for treatment of scale insects, mealy-bug or thrips. The application, in the case of ferns and palms, should be repeated after an interval of about two weeks.

The flower-buds and flowers of roses and geraniums are often eaten by small caterpillars, the larvae of small moths. Infested buds and flowers should be picked and the larvae destroyed. Spraying with an infusion of pyrethrum as the buds are forming would protect them from attack to some extent.

Many varieties of lilies are at certain seasons to be seen with their leaves badly eaten. This is done by the lily worm, the larva of a moth, *Euthisanotia amaryllidis*. An application of Paris green and lime at the beginning of the attack will protect these plants from this injury.

Ipomoea Horsfalliae, a climbing vine grown for its beautiful clusters of bright-red flowers, is often attacked by the larvae of a small moth, *Syntomeida syntomoides*. This caterpillar eats the developing buds, a severe attack often resulting in the destruction of all the buds and the conse-

Fig. 134. Leaf-cutting bee.
About 1½ times natural size. (*Original*)

quent loss of all the flowers. Hand-picking of the caterpillars is a satisfactory method of control. Paris green applied as a dust might be useful, but on account of the fact that a great part of the feeding is done inside the buds, the action of poisons is rather problematical.

Roses and many other plants, especially the silk cotton tree, are sometimes seen with the leaves very badly cut, small circular, or nearly circular, pieces being removed.

This is the work of the leaf-cutting bees of which *Megachile martindalei* shown in the illustration (Fig. 134) is one. The pieces of leaf are used by the insects for lining the interior of their cylindrical nests.

CHAPTER VI.

Insects Which Attack Man.

MOSQUITOES. Diptera.

Residents and visitors in the tropics are probably familiar with mosquitoes. These insects have for many years been known from the great annoyance which they cause by their habits of feeding. It is only in comparatively recent years, however, that the extreme importance of these small insects as carriers of disease has been recognized. Malaria, filaria, and yellow fever are all known to be

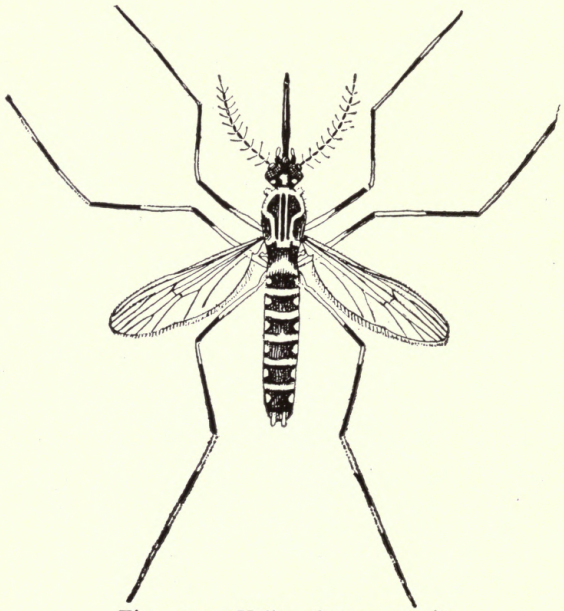

Fig. 135. Yellow fever mosquito.
Enlarged. (From U. S. Dept. Agric.)

disseminated by mosquitoes, and it has not yet been proved that any of these diseases can be communicated to human beings in any way except through the agency of these insects.

In the West Indies, the filarial parasite, which produces a disease called fever and ague, often resulting in those deformities known as Barbados leg, or elephantiasis, is transmitted by mosquitoes of the genus Culex. In other parts of the world other species are transmitters of this disease. Malaria is transmitted by mosquitoes of the genus Anopheles, and yellow fever by *Stegomyia fasciata*, Fabr. (Fig. 135). These mosquitoes all have a general distribution throughout the West Indies, with the exception of Anopheles, which is not known to occur in Barbados.

So far as is known at present, mosquitoes are able to breed only in stagnant or slowly running water, on the surface of which the eggs (Fig. 136) are laid. The larvae live in the water as wrigglers or ' water-worms ', and the pupae, which differ slightly in appearance from the larvae, are also found

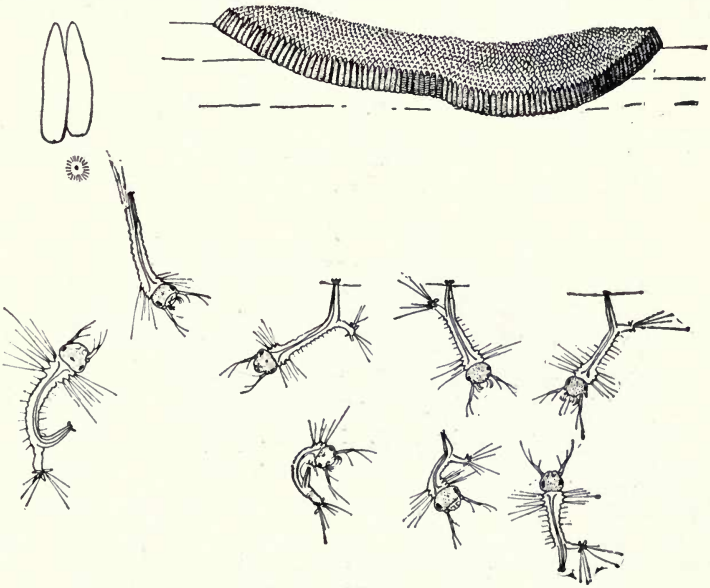

Fig. 136. Mosquitoes.
Egg mass above, with enlarged eggs at left. Young larvae below. Enlarged. (From U. S. Dept. Agric.)

in water. The larvae (Fig. 137) and pupae of mosquitoes breathe by means of air-tubes, and it is necessary for them to come to the surface in order that these tubes may come into contact with the air above. In the illustration the

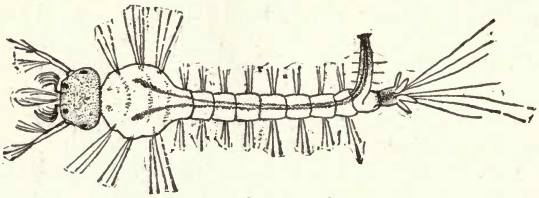

Fig. 137. Larva of mosquito.
(*From U. S. Dept. Agric.*)

breathing organ is shown as a projection at right angles to the main axis of the body.

Control. In order to get rid of mosquitoes, all stagnant water should be done away with as far as possible. All old tins, bottles, etc., should be removed; pools should be filled in or drained. Water tanks should be screened in such a way as to prevent the entrance of the adult mosquitoes for the purpose of egg-laying. Many plants are able to hold water in sufficient quantity for the breeding of mosquitoes, and these should be destroyed. Ponds and streams which cannot be done away with should be stocked with millions (*Girardinus poeciloides*, De Filippi) or other small fish, (Fig. 138) and these will also be found efficient

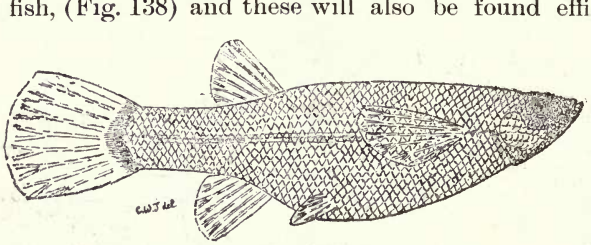

Fig. 138. Millions.
Enlarged. (*Imperial Dept. Agric.*)

in the case of garden tubs, fountains, etc., where ornamental plants are grown, as well as in cisterns and tanks which cannot be screened. Kerosene, sprayed on the surface of any water in which mosquitoes are breeding, is a very efficient means of destroying them. When the mosquito larvae or pupae rise to the surface to breathe, the kerosene

comes into contact with their air tubes and causes their death. It may be mentioned that only the female mosquitoes are capable of piercing the skin and sucking the blood of animals. The mouth parts of the male are adapted for sucking the juices of flowers.

The attacks of the adult mosquito can be prevented by the use of mosquito nets over the beds, or by screening doors and windows of dwellings. The use of citronella oil, lavender oil, eucalyptus oil, and other strongly scented substances will often be found efficient in keeping away these troublesome insects.

It is sometimes desirable to rid a house of mosquitoes and this can be done by fumigation. The fumes of sulphur or pyrethrum, or of a mixture of carbolic acid and camphor, will accomplish this object. In order that fumigation may be effective, however, it is necessary to be able to close doors and windows, so as to produce practically air-tight rooms or an air-tight house. Strips of paper pasted over cracks and crevices are very efficient in preventing the escape of gases during fumigation.

FLEAS. (*Pulex* spp.). Diptera.

The house-flea (*Pulex irritans*) sometimes occurs in sufficient numbers to cause it to be considered as a pest.

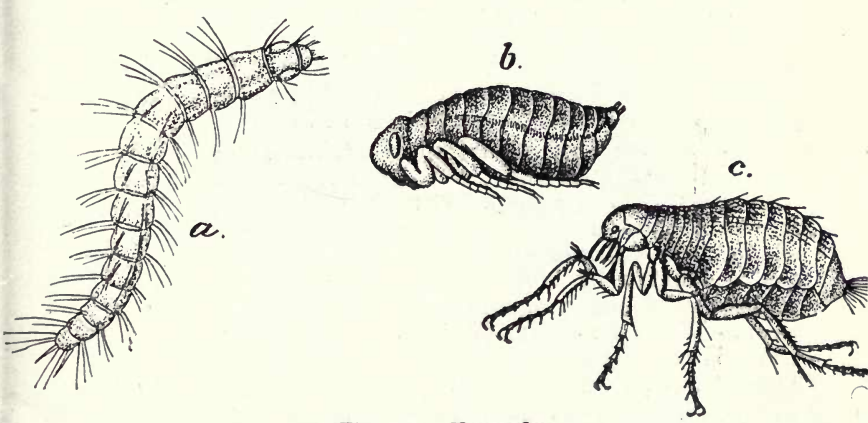

Fig. 139. House flea.
(a) larva; (b) pupa; (c) adult flea. All enlarged.
(From U. S. Dept. Agric.)

The eggs are deposited in corners, crevices in the floors and walls, under carpets and in similar locations. The larvae, which are minute worm-like maggots, (Fig. 139) live among the dust and dirt, and are said to feed on the particles of organic matter found in such places. The adults hide in clothing and bedding and attack human beings, principally at night. The mouth parts are especially adapted for piercing the skin and for sucking up their food, which is the blood of the victim attacked. The length of time required for the complete life-cycle is about four weeks.

In order to rid a dwelling of fleas after it has once become infested, it is necessary to remove the breeding places. In such a house it would be advisable to remove all carpets, rugs and floor mattings, and to have these thoroughly cleaned by beating and sweeping, out of doors. Floors should be swept and scrubbed, and great care taken to prevent the accumulation of any dust and dirt. Pyrethrum is very effectual in destroying fleas, and may be dusted in all places frequented by the adults, or in which the larvae are likely to breed. Powdered alum is said to be an effective remedy for fleas. This may be dusted in the same way as is mentioned for pyrethrum, or it may be dissolved in water, and the solution used for wiping floors. When it is found that beds are infested with adult fleas, the following simple method will probably prove very effective. Take an old sheet, and wring it out in a strong solution of alum and water and thoroughly dry it. Spread this over the mattress and under the sheet that is slept on.

The cat and dog flea (*Pulex serraticeps*, Gerv.) also attacks man, and the methods of control just mentioned will be found useful for these insects. (See Fig. 148.)

Fleas have long been known as insects which cause irritation and annoyance, but quite recently it has been discovered that certain species of these insects play an important part in the transmission of one of the most serious of diseases—bubonic plague. It has been found that rats are the means by which plague is spread. This disease attacks rats, and is communicated to the fleas which infest them. When a rat dies of plague, the infested fleas leave the dead body in search of other food, and if these insects bite human beings the disease is communicated. In addition to the killing of the fleas, it is necessary to destroy the rats also, in order to control an outbreak of plague. Most persons will hardly distinguish between different kinds of

fleas; therefore all fleas should be treated with suspicion and the greatest care exercised to prevent their occurrence.

THE CHIGOE OR JIGGER FLEA (*Sarcopsylla penetrans*). Diptera.

This insect is probably a native of tropical America, and it attacks a great variety of domestic animals, in addition to man. The adult fleas attack their host in the same way as the house flea. In addition to this, the adult female burrows into the skin, especially under the toe nails, between the toes and in any crack or crevice of the skin or flesh of the foot. As the eggs develop, the body of the female increases greatly in size until it becomes a nearly spherical object, sometimes as large as a good-sized pea. This growth of the body of the flea is accompanied by itching, severe pain and swelling, sometimes resulting in a very serious ulcer.

The jigger should be removed from the flesh as soon as its presence is discovered, great care being taken to remove the insect entire, since the bursting of the body, and the discharge of the eggs in the flesh of the host is likely to produce a serious sore. To accomplish this, a slight incision should be made with the point of a sharp, clean knife blade and the flea carefully worked out by pressure at the sides.

THE BED BUG (*Cimex lectularia*, L.). Hemiptera.

This disgusting and annoying insect (Fig. 140) is widely

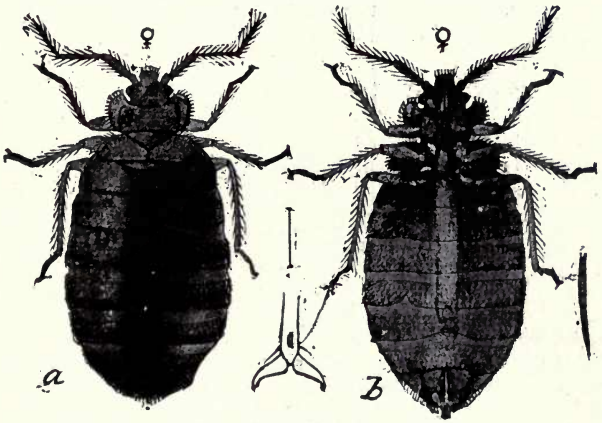

Fig. 140. Bed bug.
(*a*) *adult female gorged with blood*; (*b*) *same from below. Enlarged.* (*From U. S. Dept. Agric.*)

distributed throughout the tropics, and probably throughout the entire inhabited world. It is a flattened, brownish, ovoid insect, without wings and with mouth parts well adapted for piercing and sucking. It is very easy for a house to become infested with the bed bug and very difficult to free it from the pest.

Their flattened structure makes it possible for these insects to hide in the smallest of crevices, and they secrete themselves in any cracks or joints in the framework of beds. They also hide in cracks in the floors and walls, behind wall-paper, and in mattresses and pillows. When it is discovered that bed bugs have become established in a bed, the following procedure should be adopted. The linen, mattress and pillows should be taken out of doors and carefully searched for any of these insects. Every possible hiding-place such as seams, hems, and the knots with which the mattress is tied, should be carefully examined and brushed with a stiff brush. Sheets should be brushed and hung up in the sun, and pillows should be examined as carefully as the mattress. The frame of the bed should be taken apart, and every joint and crevice and the springs examined. If bed bugs have been established for any length of time, their hiding places will be revealed by discoloured spots caused by the excrement of these insects, by their cast skins, and the empty egg shells which are pearly white in colour. Kerosene and turpentine are excellent insecticides for the destruction of this pest. These should be applied liberally wherever any signs of bed bugs are seen, and it would be well to soak thoroughly every joint and crevice in the structure of the bed and the springs. This examination and treatment should be repeated three times at intervals of a week; and if the insect makes its re-appearance later, the entire course of treatment should be repeated. Iron bedsteads are greatly to be preferred to those made of wood, as they offer fewer opportunities for bed bugs to hide.

Bed bugs have the power to live for long periods, under conditions which make it impossible for them to obtain human blood for food. Old beds which have been stored for some time, away from any sleeping apartments, have been found to be infested and those which are used only for short periods separated by long intervals, have been known to contain the insects, which in these situations are, as might be expected, most voracious. The traveller in the tropics

would do well always to be provided with a good supply of pyrethrum or similar insect powder. A little of this substance, dusted over sheets and pillows, may provide against attack by both bed bugs and fleas, and aid in procuring undisturbed rest.

LICE. Hemiptera.

There are three species of parasitic Hemiptera known as lice, which are peculiarly adapted to life on the human subject. These are the head louse (*Pediculus capitis*, De Geer), the body louse (*Pediculus vestimenti*, Leach) and the crab louse (*Phthirius inguinalis*, Leach). The first two of these are similar in appearance and in habits. The former, however, lives only in the fine hairs of the head, the latter secreting itself in the clothing. The crab louse is smaller and broader in proportion, than the others, and it inhabits the coarse hairs of other parts of the body than the head.

The eggs of lice, commonly called nits, are small, whitish, ovoid objects attached to the hairs, or, in the case of the body louse, secreted in the folds of the clothing.

The remedies to be used for the control of these parasites are, first, cleanliness, and second, the destruction of the insects by means of a contact poison, or in the case of the body louse, by the fumigation of the clothes. The contact poisons to be used include insect powder, oils and oily mixtures, mercuric ointments and sulphur ointment.

The body louse occurs chiefly among armies and in prisons. Infested clothing may be subjected to baking or to treatment with the fumes of sulphur or tobacco. If this treatment is repeated two or three times at intervals of a few days, and strict personal cleanliness is maintained, the attack by this insect will probably be overcome

THE BLOOD-SUCKING CONE NOSE (*Conorhinus sanguisuga*, Lec.). Hemiptera.

This insect, which is sometimes called the big bed-bug (Fig. 141), belongs to a family of Hemiptera which includes

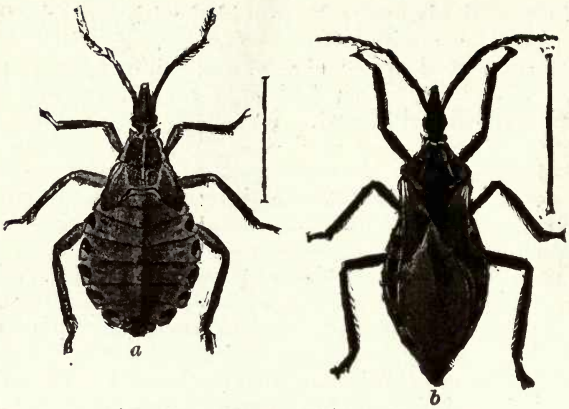

Fig. 141. Blood-sucking cone nose.
(*a*) *larva*; (*b*) *adult*. *Enlarged*. (*From U. S. Dept. Agric.*)

several forms predaceous on other insects. The blood-sucking cone nose feeds generally on other insects, but the winged adult sometimes flies into houses at night, and if opportunity offers attacks sleeping persons. The strong sucking mouth parts with which the insect punctures the skin of its host for the purpose of sucking blood is capable of inflicting a very painful wound. Cases are known of fever and severe illness, accompanied by swelling and inflammation in the vicinity of the bite, following the attack of the blood-sucking cone nose. The insect is about $\frac{3}{4}$-inch in length, of the typical appearance of the Hemiptera, the wings lying along the back, being narrower than the abdomen, the edges of which are marked with alternating areas of red and black, which latter is the general ground colour of the entire insect.

THE HOUSE FLY (*Musca domestica*). Diptera.

The house fly (Fig. 142) is probably to be considered as much a household pest, as a pest attacking man. Within the past few years, however, the agency of this insect as a carrier of typhoid fever has come to be so well known that it is included in this place rather than among the household pests.

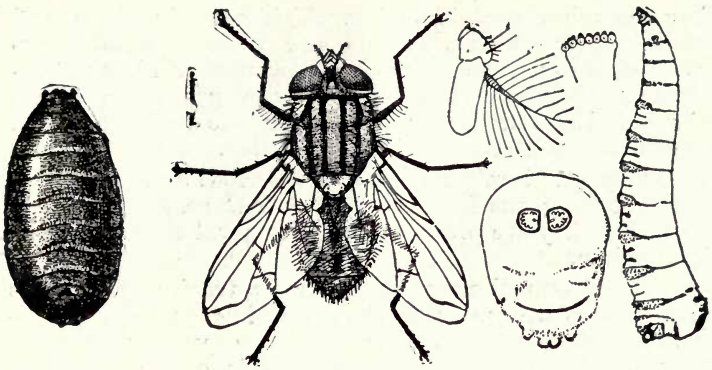

Fig. 142. House fly.
Puparium at left; adult next; larva and enlarged parts at right. Enlarged. (From U. S. Dept. Agric.)

The house fly breed in manure and decaying organic matter. Its life-cycle occupies a very short time and the females deposit a large number of eggs, thus providing for very rapid increase in numbers. House flies visit the most repulsive and unclean situations and, if opportunity offers, they go from these places directly into houses, mess tents, etc., where they walk about over food stuffs, contaminating them with any disease germs or filth which may have adhered to the hairs of their legs and bodies. The house fly is distinctly a creature of filth and uncleanliness, and the first step toward ridding a house or locality of these undesirable visitors is to remove the material and the conditions which provide them with breeding places.

Under estate conditions and in stables, manure may be treated with gypsum or air-slaked lime and thus be rendered unsuitable as a breeding place for flies.

BÊTE ROUGE (*Trombidium* sp.). Acarina.

This small mite occurs in some of the West Indian Islands in such abundance as to cause it to be considered a pest. There is a great difference, however, in the degree of susceptibility to attack, some persons being frequently and seriously annoyed by these small creatures, while others will very rarely notice them. The bête rouge is known as the harvest bug, and in some localities is called a chigger.

They are minute reddish mites which occur in grass and shrubs. They attack the ankles and wrists of persons who are exposed to them, and if left undisturbed will bury themselves in the skin. When they occur in great numbers as they sometimes do, and swarm over the arms and legs, they cause an extremely painful irritation.

These small mites have been described and figured as species of the genus Leptus—*Leptus irritans*, and *L. americana*—but they are probably only the larval forms of some Trombidium.

Several remedies are in use in the tropics against this mite. The wearing of thick boots, riding leggings, or putties, will often serve as a preventive, especially in short grass. The application of rum, whiskey or dilute alcohol will kill the bête rouge, if this can be made before the mites have burrowed into the skin. Lime juice and greasy substances, especially carbolated oil, vaseline, or tallow candle will generally be found effective. An effort should be made to prevent mites from burrowing into the skin. They can often be discovered in the centre of the little red swelling which results from the irritation caused by them, and if they are removed much of the irritation may be avoided.

CHAPTER VII.

Insect Pests of Domestic Animals.

Domestic animals in the tropics are attacked by insects and other pests to an extent perhaps greater than is the case with similar animals in cooler climates. In the small islands of the West Indies, however, certain of these pests are less troublesome than in larger tropical countries and in temperate and sub-tropical regions. The cattle ticks are an example of such pests. In some parts of the world the cattle ticks are the cause of great loss to cattle raisers and estate owners, because of the irritation to the cattle and the loss of blood taken as food by enormous numbers of these parasites, and also on account of the diseases which they transmit from one individual to another. Certain species of ticks also transmit diseases of goats and of dogs. Other pests and parasites injure the host animals principally by feeding on the blood, which they suck by means of the specially adapted mouth parts.

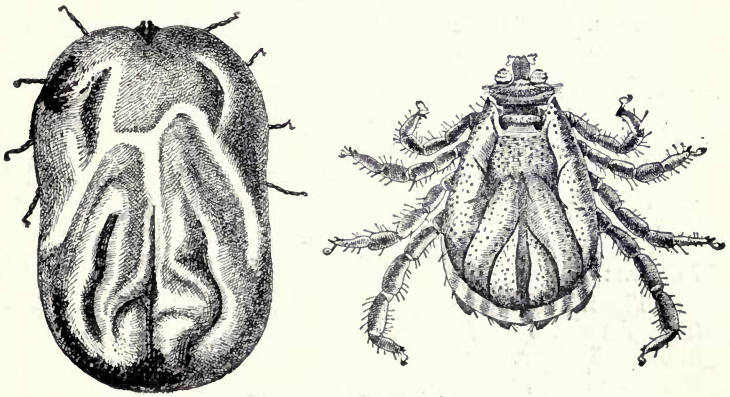

Fig. 143. Cattle tick.
Female at the left, male at the right. Enlarged.
(From U.S. Dept. Agric.)

The cattle tick (*Margaropus annulatus australis*) occurs throughout the West Indies. It is one of the mites, and not a true insect. The adult (Fig. 143) is reddish-brown in colour; the skin or integument is leathery in texture; the number of legs is eight. The length of a large female is about $\frac{1}{2}$-inch. The male is smaller and flatter than the female, which when fully fed is very much distended. The immature ticks are similar in general appearance to the adult male, being small and flat with comparatively long legs. The newly hatched larvae have only three pairs of legs, the fourth pair being acquired at the first moult.

The replete egg-laying female, as seen from above appears to be nearly all abdomen, the head and thorax being represented by a very small area at the anterior end of the body.

The eggs (Fig. 144) are laid on the ground, each female producing great numbers—from 1,500 to 3,000. The young, six-legged larvae cluster upon grass and low herbage, where they await the passing of cattle or other animals to which they may attach themselves. As soon as these 'grass ticks' or 'seed-ticks' findthem selves on a suitable host, they insert the mouth parts and begin at once to feed. These ticks do not leave the host animal until the life-cycle is complete; they moult, become sexually mature, the union of the sexes occurs, and then the female, ready to begin egg-laying, drops to the ground.

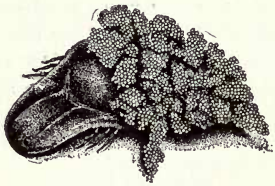

Fig. 144. Cattle tick. *Female tick depositing eggs. Natural size. (From U.S. Dept. Agric.)*

The time occupied by the West Indian cattle tick in completing its life-cycle does not seem to have been worked out, but, in the United States, *Margaropus annulatus* has been found to require about 6 or 7 weeks, divided as follows:—

The first (larval) period occupies 6 or 7 days, the second (nymph) also 6 or 7 days. The adult remains on the host another 5 days, during which time mating occurs, and at the end of this, the impregnated female drops to the ground. Another 3 days ensues before egg-laying begins, and the time required for the eggs to hatch is about 21 days.

Since development is, in general, more rapid in the warmest weather, it may safely be assumed that the life cycle of such a closely related species or variety would not be longer in the West Indies than in the case of *M. annulatus* in the United States.

Control. In the United States, a system of control has been demonstrated, which consists of enclosing cattle in one place while the ticks are dropping, and removing them to another before hatching commences. They are removed from the second enclosure before the eggs from the dropped females begin to hatch. If the cattle are by that time tick-free they may be allowed to range over any pasture on which there has been no cattle or other tick hosts for a period of some six months.

Newly hatched ticks are able to exist for about two weeks without food, after which time they die of starvation.

Where a few cattle are to be dealt with, they may be sprayed or washed with a good contact insecticide. In treating larger numbers they may be dipped, in large vats built for the purpose.

There are on the market several cattle dips and washes, especially adapted for treating ticks. These generally contain some oil or soap, and may include also arsenic.

The following mixture has been tried on a small scale, on a cow, and found satisfactory. One gallon of kerosine, 1 gallon of cotton seed oil, and 1 lb. flowers of sulphur were thoroughly mixed, and applied with a coarse cloth. The cow was washed, care being taken to ensure that the mixture came into contact with every part of the animal's skin. After an interval of a week or ten days, the application was repeated. These two applications were successful in removing all the ticks, and although the hair came off in a few places, the animal seemed to suffer no inconvenience. In adopting this method the animals should be kept on a tick-free pasture after the first application, in order to prevent re-infestation.

Cattle ticks also attack horses, goats, and dogs; but not often in sufficient numbers to be considered pests. Dogs also are attacked by the dog tick which is probably a species of Rhipicephalus.

The gold tick (*Amblyomma variegatum*) which occurs in Antigua is remarkable on account of its larger size. It is

suspected of having an influence in the spread of a skin disease of cattle which occurs in that island.

FOWL TICKS. Fowls in the West Indies are often attacked by the fowl tick (*Argas miniatus*) which though fairly abundant is not familiar to many persons. This is a flattish, mottled, grey tick which hides in crevices under boards and similar situations, coming out to prey upon the fowls at night.

Control. Fowl houses should be built in such a way as to provide the fewest possible hiding places for the ticks and other pests of fowls. The free use of lime, or of a mixture of lime and sulphur in equal parts, dusted in all cracks and crevices, is a great aid to cleanliness from pests of this kind. The perches on which the fowls roost might be protected by means of a band of tar or other sticky substance, applied near the ends of the perches in such a manner as to prevent the ticks from gaining access to the fowls at night.

These ticks are able to live for many months without food, and the fact that a fowl house has not been in use for a year, even, will not be a guarantee that it contains no ticks.

THE SCREW WORM (*Compsomyia macellaria*). Diptera.

About ten years ago, the screw worm occured in St. Lucia in such numbers as to cause a very considerable loss to owners of stock in that island.

The insect is a species of the Diptera, the adult being a two-winged fly about the size of the house-fly, or a little larger. In general appearance the screw worm fly resembles both the blue-bottle and the house-fly, the chief distinguishing feature being three longitudinal dark marks on the dorsal surface of the thorax. There, are, however, other flies possessing similiar markings, so that for an exact identification other characters need to be studied.

The female fly deposits the white, cigar-shaped eggs in any wound or open sore of cattle, horses, sheep, goats, and pigs ; and cases are on record where this insect has even attacked man. The eggs are fastened together into bundles by means of a mucilaginous substance secreted by the parent.

The maggots which hatch from the eggs are white without legs, tapering to a point at the head and ending bluntly behind. The hinder end of the body is provided with breathing pores ; these enable the maggot to breathe,

even when it is buried in the tissue of an animal, as long as the extreme end of the body comes into contact with the outer air.

The full-grown maggot is about $\frac{1}{2}$-inch in length.

The pupa is an oval, seed-like body, brown in colour, about $\frac{1}{3}$-inch in length.

The life-cycle occupies about 3 or 4 weeks, divided as follows:—

Egg	1 to 48 hours
Maggot	7 „ 10 days
Pupa	14 „ 21 days

Egg-laying begins in a very short time after the emergence of the adult.

The injury to animals attacked by the screw worm arises from the amount of irritation to the wounds infested by the maggots, the loss of blood and the destruction of tissue, and also from blood poisoning, which frequently results.

Control. In any locality where the screw worm occurs in numbers, great care should be taken to prevent the access of the fly to wounds, sores or exposed tender tissues on all domestic animals. This can be done by prompt treatment with some substance which will repel the fly, or will make it impossible for the eggs to be laid. After the maggots have actually infested the animals, the wounds should be carefully cleaned, all the insects removed and the wounds dressed.

The following substances have been tried and have given good results:—

Fish oil, used alone, serves to keep off the flies and prevent egg-laying. It may be used in a mixture with any of the following, for a dressing.

Carbolic acid. Used to kill maggots, and to cleanse and disinfect wounds. If used alone, it should be applied with a feather. Mixed with sweet oil, its action is not so severe, and it may be used more liberally.

Jeyes fluid may be used in the same manner as carbolic acid. It may be diluted with water to make a disinfectant wash.

A mixture of Jeyes fluid 3 parts and Friars balsam 2 parts, or carbolic acid 1 part and Friars balsam 2 parts, is also very efficient.

Tar (pine tar) is useful for painting surface wounds, after the maggots have been removed; it also prevents the access of flies for further infection.

Cotton soaked in any of the mixtures given above may be used to plug deep wounds, or the mixtures may be used for bathing shallow wounds. Great care shoud be taken to remove all maggots and to maintain the utmost cleanliness of the wounds, in order to promote rapid healing, and to prevent blood poisoning.

BOT FLIES. Diptera.

The bot flies of horses, cattle and sheep occasionally

Fig. 145. Sheep bot fly. *Enlarged. (From U. S. Dept. Agric.)*

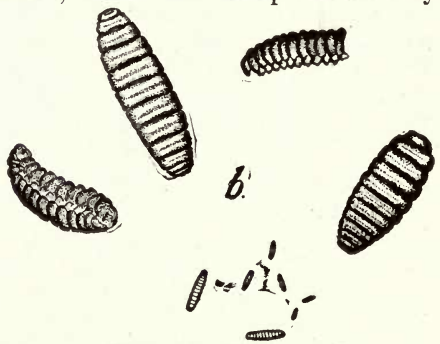

Fig. 146. Sheep bot. *Larvae of different ages. Natural size. (From U. S. Dept. Agric.)*

occur in small numbers in the West Indies. Since these are important in other countries they are briefly considered here.

Fig 147. Sheep bot. *Pupa. Enlarged. (From U. S Dept. Agric.)*

The bot flies are related insects of the order Diptera. The sheep bot (*Oestrus ovis*, L.) infests the nasal cavities and head of the sheep (Fig. 145). The maggots (already hatched from the egg) are deposited by the female parent in the nostrils of the sheep. (Fig. 146). The larvae then make their way up the nasal passages into the head, where they grow and develop throughout the larval period which occupies 8 to 10 months. At the end of this time, the full-grown larvae are expelled

by the sneezing of the sheep. They burrow into the ground, where the pupal stage is passed (Fig. 147). This occupies some 4 to 6 weeks.

Control. When the sheep bot occurs in numbers, various plans are adopted to prevent the access of the adult fly or to dislodge the grub. The latter is considered the most useful measure to take with this insect. For this purpose, the animal may be caused to sniff a small quantity of dry lime, and the sneezing thus induced will dislodge the maggot if it has not become too well established. The use of a feather dipped in turpentine will cause the detachment of maggots in the lower part of the nasal passages; but when they have become fixed in the sinus between the bones of the head, to loosen them is extremely difficult, if not impossible. The use of some substance, on the nose of the sheep, which is disagreeable to the fly may prevent egg-laying to a certain extent, but cannot be depended on entirely, especially where these insects are abundant. Tar has been used for this purpose.

The horse bot (*Gastrophilus equi*, Fabr.) differs in several particulars in its life-history from the preceding. The eggs are not hatched within the body of the female fly; they are deposited on the long hairs of the forelegs and chest of the horse, where they hatch. The maggots are removed by the tongue of the horse in licking itself, and carried to the mouth and swallowed. The larvae attach themselves to the lining of the stomach of the horse, where they remain for several months. When fully grown they loosen their hold and are passed out of the body of the host with the dung. The pupal stage is passed in the ground like that of the sheep bot.

The bot of cattle is known as the warble fly. This is *Hypoderma lineata*, Will., or *H. bovis*, de G. The adult female deposits its eggs on the hair of the shoulders, neck, etc., of the cattle, from which places eggs or newly hatched larvae are licked off and swallowed by the host. The maggots penetrate the walls of the alimentary tract and finally reach the subcutaneous tissues of the back, where they remain for some months, throughout the pupal stage. When fully grown, the maggots penetrate the skin of the host and fall to the ground, and then the pupal stage is passed through in a similar way to that of the bots of the sheep and horse.

Control. When warble flies are very abundant they may be prevented from laying eggs on the cattle by smearing the necks and backs of the animals with a repellent mixture, which may be made by mixing together :—

Flowers of sulphur	4 oz.
Spirits of tar	1 gill
Whale-oil	1 quart

During the egg-laying season, this mixture should be applied once a week.

Warble flies do not like deep shade, and it is said that they will not fly over water ; consequently cattle that have access to deep shade, and pools of water in which to stand and wade, should be but little troubled by these pests.

When the swellings on the backs of the animals are first seen, a light rubbing with kerosene will kill the grubs. This is due to the fact that the oil penetrates through the holes in the skin of the cattle, through which the maggots breathe. Later, the insects may be squeezed out of the swellings and destroyed.

FLEAS.

Cats and dogs are attacked by fleas (Fig. 148) which

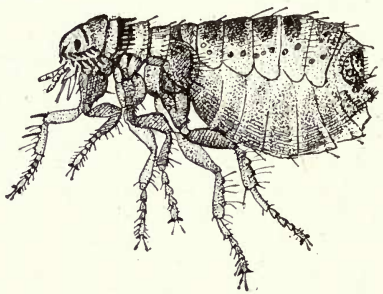

Fig. 148. Cat and dog flea.
Enlarged. (*From U. S. Dept. Agric.*)

in the adult stage live among the hairs of the body, and obtain their food by piercing the skin and sucking the blood of the host. The life-history is similar to that of the house flea (*Pulex irritans*), and the remedies to be used are also similar (see Fig. 138). The eggs of the cat and dog flea (*Pulex serraticeps*) are dropped to the floor, or to the ground, where they hatch, and where the grub-like maggots live and develop.

The free use of pyrethrum or similar insect powder will completely free dogs, cats or other animals from fleas, and cleanliness and the use of pyrethrum in the sleeping places of the animals will be sufficient to keep them practically free of these pests.

POULTRY LICE.

The poultry lice belong to the order Platyptera, and are known as the biting bird lice. The principal of these is *Menopon pallidum*. This is an active, yellowish insect, about $\frac{1}{20}$-inch in length, with biting mouth parts, and without wings, even in the adult condition. The eggs are small, elongate-oval, and attached to the feathers of the birds. The young live on the skin of the fowls, at the base of the feathers, while the adult insects wander about actively over the skin and through the feathers. The food of poultry lice is composed of the epidermal scales and the fine portions of the feathers. Poultry do not suffer a loss of blood from the attacks of lice, but a constant irritation, rather, due to the presence of these pests.

Fowls infested with lice can often be distinguished by their ragged plumage, and by the fact that they are constantly dusting themselves.

Control. Dust baths containing wood ashes or sulphur or tobacco dust are useful in this connexion. An infusion of tobacco stems is useful for dipping infested fowls, and tobacco dust or insect powder, thoroughly applied among the feathers, also gives good results. Sitting hens may be protected by the use of naphthalene, sulphur, onion leaves and tobacco, in the nests. Fumigation of the fowl-house with sulphur, repeated two or three times at intervals of 10 days, is of value in connexion with houses that can be tightly closed.

POULTRY MITES. Acarina.

The poultry mite (*Dermanyssus gallinae*, de Geer), like the red spider and ticks, is not a true insect. This pest feeds on the blood of the host, and frequently occurs in such numbers as to cause the death of young chicks, and to reduce greatly the vitality of older fowls. The mites, which are called nimbles in the West Indies, are entirely nocturnal in their attacks on fowls, hiding in and about the roosting places during the day, and swarming out to feed at night.

Control. Any arrangement which prevents the mites from gaining access to the fowls during the hours of roosting will serve as a satisfactory check on these pests, and this, combined with the use of lime and sulphur, as suggested for the fowl tick, will give a practical immunity from their attacks. Of course, cleanliness is a prime requisite in connexion with all parasites of poultry. All droppings should be removed every day, or at the very least twice a week. The use of a sticky substance, or kerosene, at the ends of the perches, as already suggested for the fowl tick, is very useful in this connexion

Fowls are often seen with deformed or scabby legs—a condition resulting from the presence of a burrowing mite, the itch mite of fowls (*Sarcoptes mutans*, Robin and Lang). Fowls suffering from this pest should not be introduced into a flock where it does not occur.

Badly infested fowls should be killed, but in cases of mild infection the application of oily ointments to the scabs will result in their removal and in the death of the mites. Care must be taken in the use of oils on the feet of fowls, as an excess might produce an undesirable effect on the normal scales.

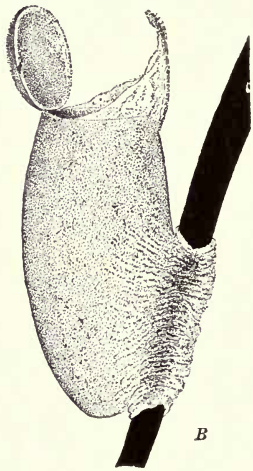

Fig. 149. Hog louse egg which has been hatched, and the hair to which it is fastened.
Enlarged. (*From U.S. Dept. Agric.*)

THE HOG LOUSE (*Haematopinus suis*). Hemiptera.

This insect is of occasional occurrence in the West Indies. Like those of the other true lice, its mouth parts are adapted for sucking. The eggs (Fig. 149) are attached to the hairs of the animal, and the parasites (Fig. 150) spend their entire life-cycle on the body of the host. Severe attacks of hog lice cause animals to lose flesh

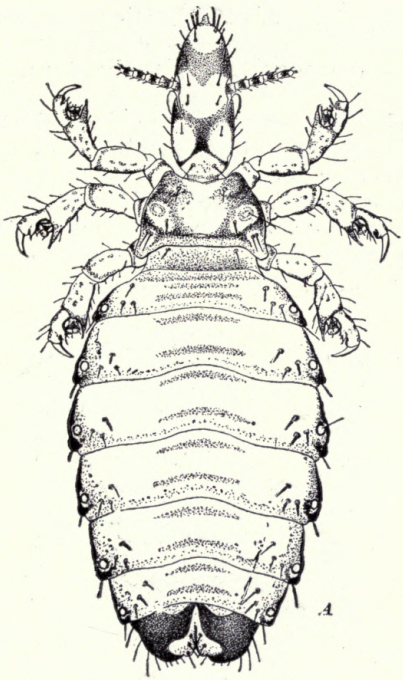

Fig. 150. Hog louse.
Adult female. Enlarged. (From U.S. Dept. Agric.

The remedies to be used are such contact poisons as may be safely employed. Tobacco water, dilute carbolic acid, kerosene emulsion and similar materials, applied as sprays by means of a force pump, should give good results.

CHAPTER VIII.

Household Insects and Pests of Stored Products.

COCKROACHES. Orthoptera.

Cockroaches are very common throughout the tropics, occurring in houses, buildings of all sorts, and in a great variety of out-door situations. The species which live in dwelling houses are offensive and injurious. They impart their distinctive and disagreeable odour to eatables or utensils with which they may come into contact, and they cause serious injury by their attacks on book bindings,

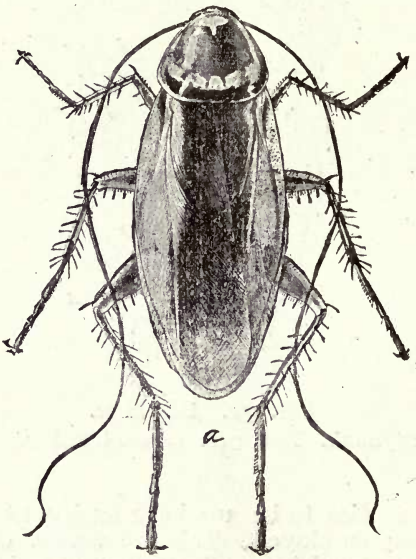

Fig. 151. American cockroach.
Enlarged. (From U. S. Dept. Agric.)

clothing, food stuffs, etc. The two principal household species are very wide-spread in their distribution, occurring in many parts of the world. The larger of these is *Periplaneta americana* (Fig. 151); the closely related form *P. australasiae* (Fig. 152) is slightly smaller. These are the common brown cockroaches, $1\frac{1}{2}$ inches to 2 inches in length, and with a spread of wings of nearly 4 inches

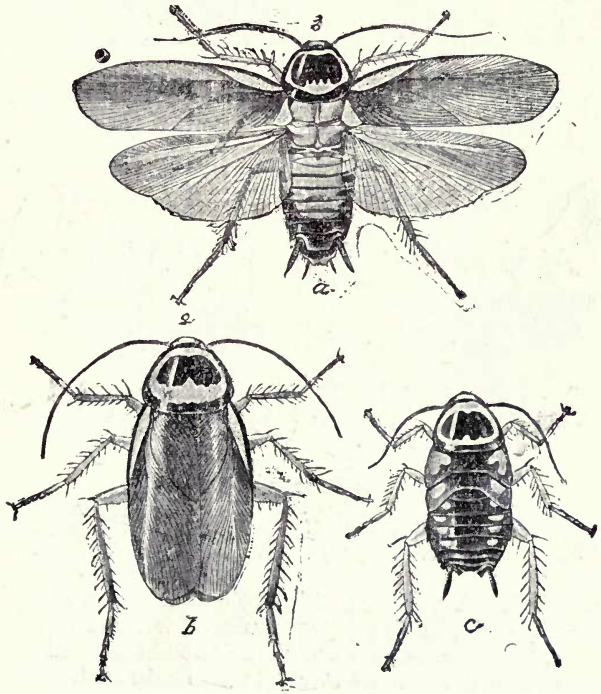

Fig. 152. Australian cockroach.
(*a*) *male with wings spread*; (*b*) *female*; (*c*) *immature form. Natural size.* (*From U. S. Dept. Agric.*)

They are very conspicuous on moist, hot nights in the wet season, when they fly into lighted rooms. The immature forms are generally to be seen in numbers, if one enters a kitchen or storeroom at night, carrying a light. The eggs of the cockroaches are laid in masses, in the form of a capsule. The young are similar in shape and appear-

ance to the adults. The flattened body and spiny legs of cockroaches make it possible for them to penetrate into very narrow cracks and crevices, where they hide during the day.

A small cockroach often occurs in the living rooms of houses, hiding by day behind pictures and ornaments, and inside presses, chests of drawers, under tables and in like situations. The bright-brown egg-capsules may often be found in the hiding places of these insects ; from such places these forms sally forth at night, committing depredations similar to those of the larger species. They are related to, if not the same as, the German cockroach *Ectobia germanica*, shown in Fig. 153.

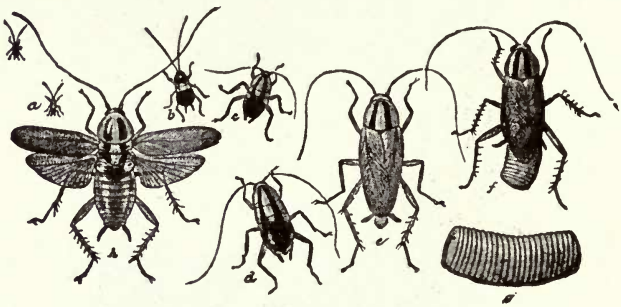

Fig. 153. The German cockroach.

(a, b, c, d) four stages of growth ; (e), adult ; (f), adult female with egg case ; (g), egg-case enlarged ; (h), adult with wings spread. All natural size except (g). (From U. S. Dept. Agric.)

Control. A mixture of boracic acid and sweet chocolate or molasses, in equal parts, placed where these insects are abundant serves as a very efficient check. A mixture of flour and plaster of Paris is also said to be useful in this connexion. If the supply of these mixtures is repeated at intervals of six weeks or two months, or whenever it is noticed that cockroaches are on the increase, it should be possible to keep them reduced to very small numbers all the time. Cleanliness in kitchens and storerooms, and the careful removal of all pieces of food, will also be found to help in reducing the numbers of these disagreeable pests.

Natural Enemies. The egg masses of cockroaches are attacked by hymenopterous parasites of the genus Evania.

The common West Indian species is not definitely known to be a parasite of cockroaches, but it seems likely that this is the case. Cockroaches are eagerly eaten by poultry, whenever the birds can find them.

SILVER FISH (*Lepisma* sp.). Orthoptera.

The silver fish (Fig. 154), fish scale or fish moth, as they are often known, are familiar to most residents in the tropics. They infest books, papers and photographs. Various articles of clothing such as woollen and silken fabrics are generally believed to be attacked by these pests, and it is sometimes stated that even cotton and linen are eaten by them. They seem to be most attracted, however, by material in which there is an abundance of starch or paste. A book solution, consisting of a mixture of 1 oz. of corrosive sublimate, 1 oz. of carbolic acid and 2 parts of methylated spirit, applied to the bindings of cloth-bound books, will generally suffice to prevent the attacks of both cockroaches and silver fish. Bookbinders in the tropics should use a paste containing bluestone (copper sulphate) at the rate of ½-oz. to every pound of the paste, to prevent the bindings from being eaten by these pests. The abundant use of naphthalene in the form of flakes, or in balls known as moth balls or camphor balls, will be found very useful in keeping these pests out of drawers, wardrobes, storage boxes, book-shelves and similar places.

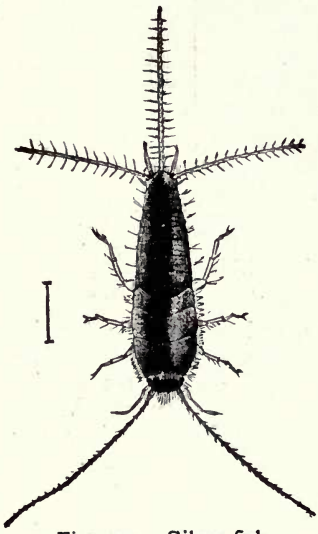

Fig. 154. Silver fish.
Adult insect. Enlarged.
(*From U. S. Dept. Agric.*)

THE HOUSE CRICKET (*Amphiacusta caribbea*). Orthoptera.

This insect (Fig. 155) is often known in the West Indies as the house or sick cricket. It occurs, sometimes in great numbers, in houses, sheds, storage rooms, etc. It is

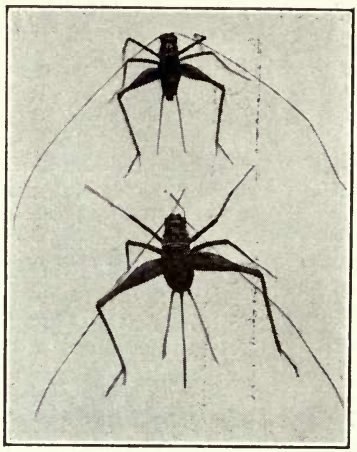

Fig. 155. House or sick cricket.
Reduced. (*Original.*)

said to feed on food stuffs generally, and to be fond of moist situations, but it is known to occur and apparently to thrive, in dry rooms where the only available food material appeared to be books, papers and similar substances. When these insects occur as pests in dwelling houses, they are generally found in the kitchens and living rooms, where they may be controlled by the same means as are recommended for cockroaches.

ANTS. Hymenoptera.

Several species of ants are liable to establish themselves in houses, and cause a great deal of annoyance to the inmates. The very minute sugar ant (*Tapinoma melanocephalum*), which is pale-reddish in colour and attacks sugar, jams, and similar substances, and the so-called red or stinging ant (*Solenopsis geminata*) which sometimes becomes very abundant, are perhaps two of the most common. The mad or crazy ant (*Prenolepis longicornis*), which is a slender, black insect with long legs and long antennae is also a well-known form. Another one, which is a large, stout, dark-coloured ant (*Camponotus* sp.) lives in the timbers, which it sometimes very materially weakens by its excavations.

In order to get rid of ants in the house, it will generally be necessary to locate the nest; for unless the nest is destroyed, the egg-laying females continue their activities, and the supply of the individuals in the colony is maintained. The nest can generally be located by putting down a bait and watching to see the direction taken by the ants that have visited it. The nest may be destroyed in several ways, the method used depending somewhat on its location. Carbon bisulphide, cyanide of potash in solution, and hot water, are all useful for this purpose.

Two or three ounces of carbon bisulphide poured into the principal entrances of the nest will evaporate and produce poisonous fumes which have great power of penetrating the galleries and killing the ants, both young and adult. In using this, entrances and exits should be plugged, to prevent escape of the fumes. Cyanide of potash in a 2-per cent. solution is used in the same way. The poisonous fumes are given off more slowly; but if the openings leading to the underground portions are thoroughly stopped, the ants will all be killed. Cyanide of potash is very poisonous, and must be used with great care; it should not be entrusted to servants.

In using hot water for this purpose, the fact must be borne in mind that it rapidly cools on coming into contact with the ground, and that in order to produce any greatly increased temperature in an ants' nest at a depth of 6 or 8 inches, a liberal supply must be used.

Most species of ants seem to have an extreme dislike for corrosive sublimate. Safes, larders and tables may be protected from invasion by washing with a solution containing corrosive sublimate, or in the case of those which swing from above, by soaking a portion of the rope by which they are hung with this poison. Ants will generally not cross a surface that has been treated with corrosive sublimate in this manner. The book solution, which has already been mentioned (p. 145), is useful for this purpose.

The practice of standing the legs of a table or safe in vessels containing water and kerosene is well known to all residents in the tropics, as is also the use of a device which accomplishes the same purpose in connexion with hanging safes and larders. This is made by using an arrangement like an inverted cone to hold the oil and water;

through the apex of the cone an iron hook passes, which attaches to the rope above and the larder below in such a manner that when this is in place ants which attempt to reach the interior of the larder by travelling down the rope by which it is hung find their progress impeded by the water and oil contained in the cone. (Fig. 156.)

Ants may be collected and killed by the use of a sponge which has been dipped in a sugar and water mixture, or the hoofs of cows, called cow heels, or any bone such as chicken, beef, or mutton bones. These may be

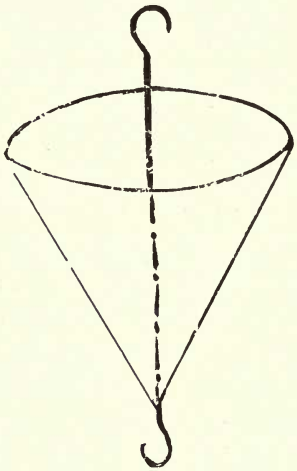

Fig 156. Hook for hanging safe.
(*Original.*)

put down where ants are abundant, and when they are covered with the insects, dropped into boiling water. If this is repeated frequently for two or three days, a sufficient number of ants will be killed to afford relief from their ravages. Some species of ants apparently leave the nest and establish a new one when they find their numbers rapidly diminishing. It must be borne in mind, however, that ants are not always attracted to the same food or bait, some species being very fond of sugar and starchy substances, while others are fond of meat, and if one form of bait is not found effective it is necessary to try another.

WHITE ANTS. Platyptera.

The Termites or so-called white ants (Fig. 157), or wood ants, are not true ants, but get their name from the similarity of their social organizations to those of the true ants in the order Hymenoptera. In their structure and life-history they more nearly resemble such insects as the pond-flies and the lace-wing flies. They live in large colonies which generally have an extensive central nest containing one or more fertile egg-laying queens, and enormous numbers of workers. These queens attain a size much larger than any of the workers, because of the

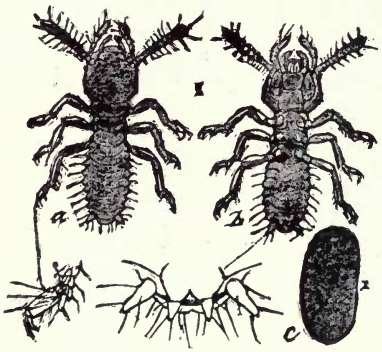

Fig. 157. White ant.
(a) newly hatched larva ; (b) same from below ; (c) egg, much enlarged. (From U.S. Dept. Agric.)

enormous distention of the abdomen which results from the development of the organs connected with egg-laying. (Fig. 158.)

These insects are nearly always blind, and they hide from the light. When it is necessary to cross an exposed surface, they build tunnels or covered galleries, through which they travel from place to place. They feed upon wood, and are able to excavate timbers and lumber used in construction, to such an extent as to render them entirely worthless. They often attack picture frames, chairs, tables and other furniture, especially in old houses where these articles come into contact with the walls, or where they are not often moved.

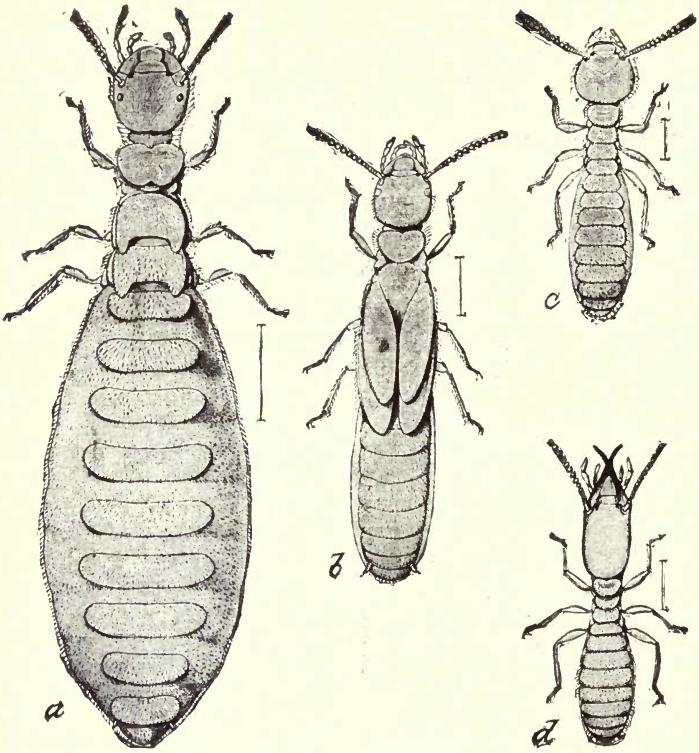

Fig. 158. White ant.

(a) queen ; (b) nymph of winged female ; (c) worker ; (d) soldier. All enlarged. (From U. S. Dept. Agric.)

Wood ants are very difficult to control, when they have become established in or about buildings. The nests can sometimes be located, and if these can be thoroughly destroyed the numbers of the ants can be greatly reduced. These nests are often to be seen as irregular woody masses on the trunks of trees, and where they are thus found they may be cut down and removed. Domestic fowls and turkeys are very fond of these insects, and will eagerly eat them if the nests are broken up so that they are exposed. Sometimes, however, no nest can be found ; but if any of their galleries can be located, many of the ants can be killed by means of poisons. A mixture of arsenic

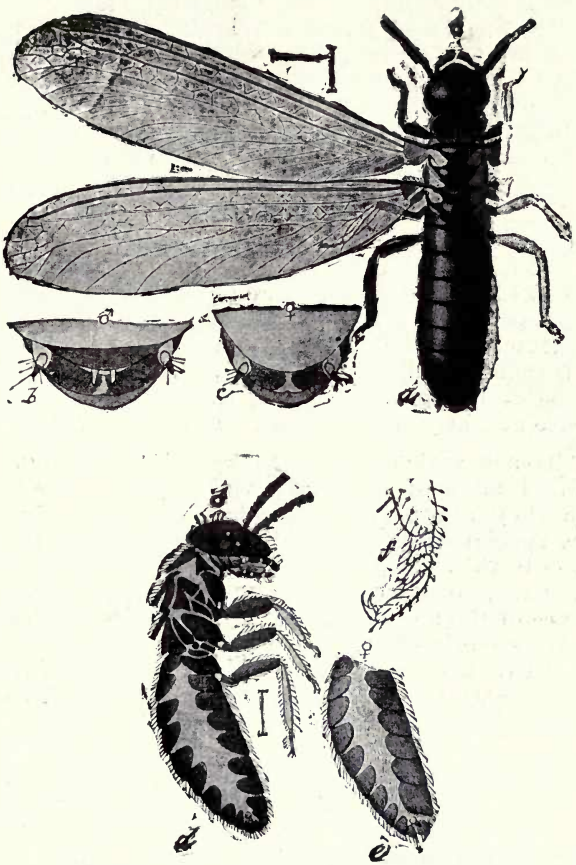

Fig. 159. White ant.
a) adult male; (d) same side view; b, c, d, e and f, structural details. a, d and e enlarged; b c, and f, greatly enlarged. (From U. S. Dept. Agric.)

and sugar or strychnine and sugar can be put down in these galleries as a poison bait. The insects which are killed by this are eaten by other insects in the nest and the poison becomes widely distributed. A mixture of oak or spruce sawdust and either of the poisons mentioned may also be used as a bait. If a small box containing this mixture is placed in a building where wood ants are

known to occur, and is kept slightly moist they will probably find it and will feed upon it. Sawdust or sheep manure in boxes, barrels or bags, left standing on the ground for some time, is attacked by wood ants. This fact suggests the possibility of successfully using poison baits in this manner.

THE CLOTHES MOTHS, (*Tinea* spp.). Lepidoptera.

Articles of clothing, especially woollens, furs, and feathers, when stored for any length of time, are liable to be attacked by the caterpillars of these small moths, and housekeepers are generally familiar with the results of these attacks. When such articles of clothing are taken out of trunks and packing cases, very minute moths are often seen flying about, and examination reveals the presence of many of the larvae.

All such articles of clothing should be thoroughly aired and brushed at least twice a year. The boxes in which they are packed should be carefully lined with paper, special care being taken that there are no cracks or holes in this. The free use of naphthalene crystals or moth balls, in the boxes, will generally prevent the entrance of the moths. Small articles may be enclosed in tight bags made of paper or cotton, since these insects will not eat through cotton, even for the sake of reaching the more attractive contents. Fumigation with carbon bisulphide is also useful for their control.

THE CIGARETTE BEETLE (*Lasioderma serricorne*, Fab.). Coleoptera.

This insect attacks a great variety of stored food stuffs but is probably best known in the West Indies as a household pest from its injury to books, cardboard boxes, photograph frames and similar articles, although it has a wide range of food materials, similar to that of the drug store beetle. Books standing on shelves will often be found with holes bored through the covers, and even through the entire thickness of the book. When such a book is opened, irregular tunnels through the cardboard of the cover, especially at the back near the binding, may often be seen, and search will generally reveal one or more small whitish grubs. These are the larvae of the

cigarette beetle. The adult is a small, brownish beetle (Fig. 160) about $\frac{1}{16}$-inch in length. To prevent injury by this insect books should be treated with book solution, and should be examined at least twice a year. Wherever signs of this insect are found in the binding of a book, careful search should be made until the grubs, pupae or adults are found. If any fine black dust is seen, or any holes or tunnels noticed, the presence of the cigarette beetle

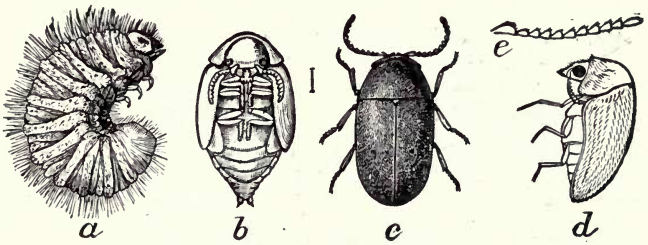

Fig. 160. Cigarette beetle.
(a) larva ; (b) pupa ; (c) adult ; (d) adult, side view ; (e) antenna. All greatly enlarged, (e) still more enlarged. (From U. S Dept. Agric.)

should be suspected, and search should be continued until it is certain that all the insects have been found. Boxes and other articles made of cardboard ought to be also carefully examined from time to time, and the insests killed whenever found. Useless and discarded articles of this sort should always be destroyed, preferably by burning, as they serve as breeding places for these insects. Fumigation with carbon bisulphide is an excellent means of destroying the cigarette beetle.

THE DRUG STORE BEETLE (*Sitodrepa panicea*, Linn.).

This beetle is a very destructive insect, similar in appearance to the cigarette beetle, when examined without the aid of a magnifying glass, and is much like it also in the various substances which it attacks.

The insects (Fig. 161) attack cereals, food stuffs and seeds, and also many articles and materials of greatly varying nature.

The larvae tunnel into books, cardboard boxes and picture frames, and roots and seeds, such as ginger and

cayenne peper, tobacco and cigars, and even poisonous substances such as aconite and belladonna. Boots and shoes, in the manufacture of which cardboard or cloth has been used, are often seriously injured if kept in stock for any length of time, for not only is the cardboard tunnelled through repeatedly, but even the leather does not escape the attacks of the voracious larvae.

The methods of prevention and control are the same for this as for the preceding insect.

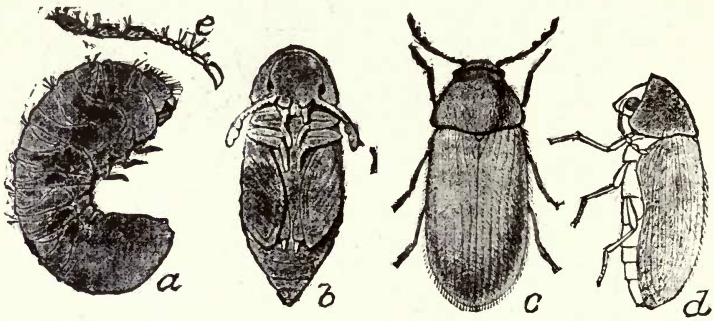

Fig. 161. Drug store beetle.
(a) larva ; (b) pupa ; (c) adult ; (d) adult, side view. enlarged.
(From U. S. Dept. Agric.)

THE MEAL WORMS AND MOTHS AND THE GRAIN WEEVILS.

Flour, bran and meal, as well as seed for planting, such as Indian corn, Guinea corn, peas and beans, are attacked by a number of minute insects, which in spite of their small size are capable of causing a considerable amount of injury.

There are two species of weevils (*Calandra granaria* and *C. oryza*), which are almost cosmopolitan in their habitat, and which are very general feeders, attacking stored grain of all kinds. The grain weevils (see Fig. 162) are small snout beetles, dark-brown, or black in colour, about $\frac{3}{16}$-inch in length. The larvae are legless grubs, very short and thick, with a much wrinkled skin.

The saw-toothed grain beetle (*Silvanus surinamensis*, L.) is one of the commonest of the grain insects. The adult is about $\frac{1}{10}$-inch in length and brown in colour. The common name is derived from the presence of tooth-like

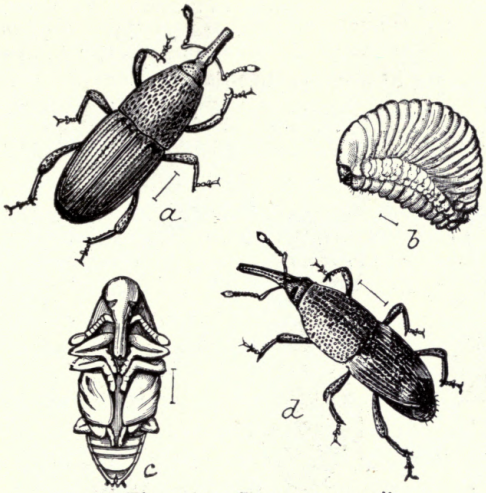

Fig. 162. Granary weevil.
(a) beetle; (b) larva; (c) pupa; (d) The rice weevil; all enlarged. (From U. S. Dept. Agric.)

projections on the lateral margins of the thorax (Fig. 163). The larva is a slender grub with a pair of club-shaped antennae and three pairs of legs. Both larvae and adults feed on flour, meal, preserved fruits, nuts, and seeds of many kinds.

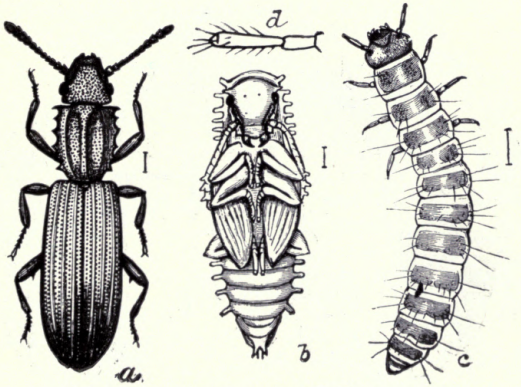

Fig. 163. Saw-toothed grain beetle.
(a) beet e; (b) pupa; (c) larva; (d) antenna of larva. (a), (b) and (c) enlarged, (d) more enlarged. (From U. S. Dept. Agric.)

The confused flour beetle (*Tribolium confusum*, Dav.) is one of the most injurious insects to flour and prepared cereal foods, with even a wider range of food than the preceding insects of similar habits.

The adult is a reddish-brown elongated beetle, about $\frac{2}{16}$-inch in length, and the larva a cylindrical grub about $\frac{1}{4}$-inch long (Fig. 164).

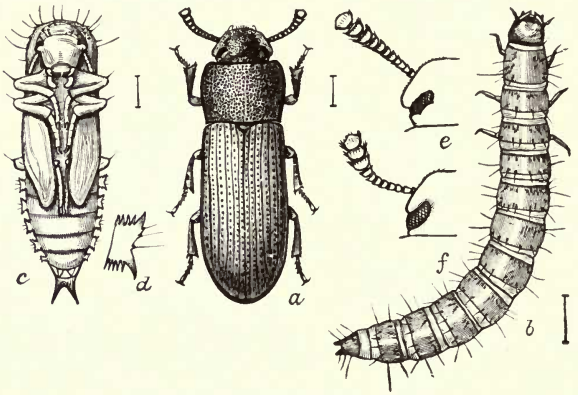

Fig. 164. Confused flour beetle.
(*a*) *beetle*; (*b*) *larva*; (*c*) *pupa*; (*d*) *lateral lobe of pupa*; (*e*) *head of beetle showing antenna*; (*f*) *same of Tribolium ferrugineum*; *all greatly enlarged.* (*From U. S. Dept. Agric.*)

The angoumois grain moth (*Sitotroga cerealella*, Oliv.)

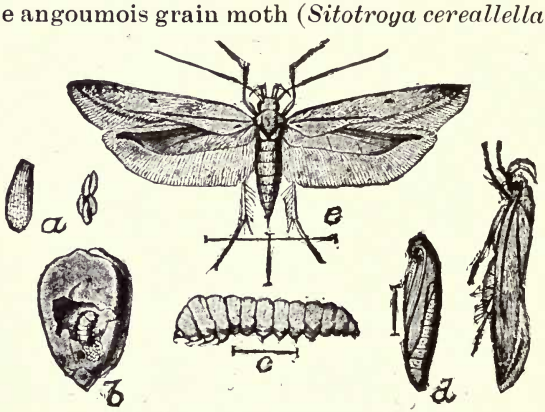

Fig. 165. Angoumois grain moth.
(*a*) *eggs*; (*b*) *larva at work*; (*c*) *larva, side view*; (*d*) *pupa*; (*e*) *moth*; (*f*) *same, side view.*) (*From U. S. Dept. Agric.*)

is a minute insect related to the clothes moths already mentioned. The adult measures about $\frac{2}{3}$-inch across the spread wings, and has a length of body of about $\frac{1}{4}$-inch. The moths of the family to which these insects belong are characterized by the presence of a very delicate fringe on the margin of the hind wings (Fig. 165).

The larva bores into the kernels of Indian corn and other grains, eating out the interior, and completing the larval and pupal periods of growth in this place. The adult emerges through a small round hole which has been made by the larva.

This insect generally attacks stored grain, but sometimes the eggs are deposited on grain in the field, and the feeding and breeding are continued after the grain is harvested and stored.

Control. The control of insects attacking grain, flour, meal and similar substances is not particularly difficult when these are stored in rooms or buildings which are sufficiently tight to be fumigated.

Carbon bisulphide, used at the rate of 1 lb. for each 1,000 cubic feet, or in bins full of grain, at the rate of 1 lb. to every hundred bushels, is very useful in this connexion. Very few warehouses in the West Indies are constructed in such a manner as to allow of their being made air-tight except at a considerable expense. A special fumigating room might well be maintained in connexion with any warehouse where a large stock of grain and food stuffs is kept, in order to facilitate fumigation when necessary.

In the household, however, where small quantities are to be dealt with, and where supplies are not kept for long periods, the matter is fairly simple. In the first place, the store-room should be frequently thoroughly cleaned. If flour, meal, and similar substances are found to be infested, they should be passed through a fine sieve, to remove all the insects, and then placed in an oven and subjected to a high temperature for 15 or 20 minutes, in order to kill the eggs.

Seeds for planting, drugs, etc., may be successfully treated by means of carbon bisulphide.

The pea and bean weevils, though commonly called weevils, are rather unlike the grain weevils already described (Fig. 162), being broader in the body, with a short thick snout and prominent antennae. They belong to the

genus Bruchus, of which there are several species, very much resembling each other in appearance, in habit, and in the plants they attack. They are small insects, usually greyish in colour, with darker markings. The larvae are short, thick, almost legless grubs, which live and complete their development within the seeds of beans and peas (Figs. 166 and 167).

Fig. 166. Cow pea weevil.
Enlarged.
(From U. S. Dept. Agric.)

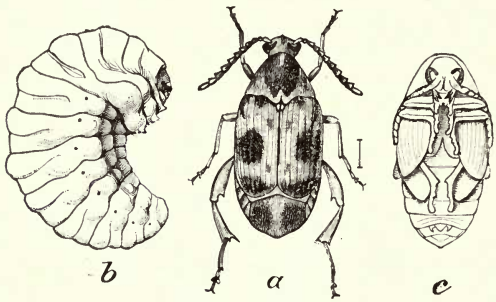

Fig. 167. Four-spotted bean weevil.
(a) beetle; (b) larva; (c) pupa. All enlarged.
(From U. S. Dept. Agric.)

The female parent deposits eggs on, or in, the seed vessel (pod) of the food plant, and the young larvae penetrate into the developing seed.

These insects often cause much injury to stored peas, beans and the like, which are intended for planting, by destroying the germinating power. The adults emerge later through a round hole in each seed that has been attacked.

Control. For the control of the pea and bean weevil, certain rules should be observed. It should be one rule to plant only uninfested seed, and another to destroy as far as possible the breeding places of the weevils during the time between crops of their food plants. When it is known or suspected that these insects have been abundant during the ripening of the crop in the field, the seed should be fumigated with carbon bisulphide soon after being harvested.

The last pests in this division, to be considered, are the ripe fruit flies, which are often seen on and about ripe fruit as numbers of very small insects. If these are examined, they will seem to be very handsome: the body a pale yellow,

the wings a clear honey yellow, and the eyes reddish with opalescent changes. There are many species of these in the West Indies, belonging to the genus Drosophila. The parent fly deposits eggs in ripe fruit, where the larvae very rapidly develop. The life-cycle of these insects is extremely short, only about ten days being required for the completion of the entire development, from the laying of the eggs to the appearance of the adult insects. Fig. 168 shows *Drosophila ampelophila*, Loew., which is very common in the United States.

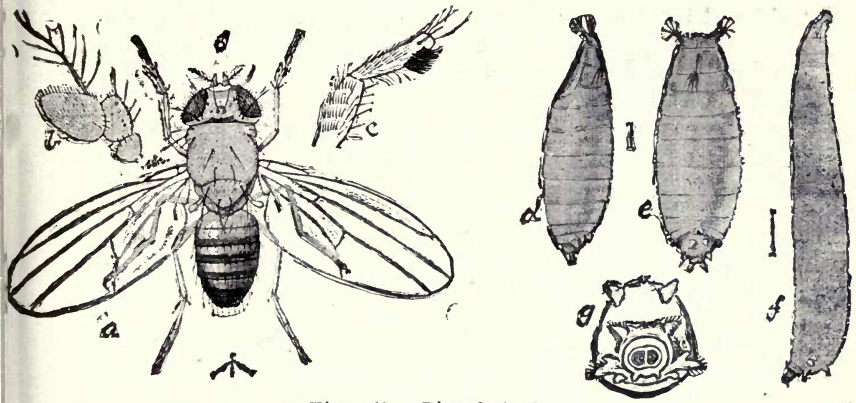

Fig. 168. Ripe fruit fly.

(a) adult; (b) antenna of same; (c) base of tibia and first tarsal joint of same; (d) puparium, side view; (e) puparium, from above; (f) full grown larva; (g) oral spiracles of same. Enlarged. (From U. S. Dept. Agric.)

The most satisfactory method of controlling these flies is to remove over-ripe fruit, and to protect all other fruit by means of a fine muslin. Fruit on the table may be protected by a special dish cover, made by stretching muslin on a suitable frame, and larders may be equipped with a compartment enclosed in muslin, in which to keep fruit.

CHAPTER IX.

The Control of Insects.

In the preceding pages, insect pests have been considered in four general groups: the insect pests of crops, the insects which attack man, insect pests of domestic animals, and household insects, including those which attack stored products.

In the matter of control, the same principles apply to all these groups, and control measures fall under two heads: one preventive, the other remedial.

In dealing with insects of all kinds, preventive measures are those which aim at debarring insects, by the destruction of their breeding places and of their food supplies, from developing to troublesome numbers, especially during the breeding season.

Remedial measures are those by means of which the insects are destroyed after they become numerous. The use of insecticides comes under this head.

Preventive Measures.

General. Preventive measures are prophylactic and sanitary. In the case of field crops the methods employed include rotation of crops, resting or fallowing the land, the destruction of old plants after the crop is reaped, and of all dead and rotten portions of plants which are likely to furnish breeding places for pests. The clearing away of wild plants in which pests of crops develop is a part of the clean cultivation which comes under this head.

These dead and worthless parts of plants should be burned or disposed of in such a way that all insects contained in them will be destroyed. Sugar-cane stumps often enable enormous numbers of weevil borers to breed to maturity. Old cotton plants furnish breeding places and food to scale insects, leaf-blister mite and other pests.

Insects in the soil are able to live with very little or no food over the short interval which often ensues between two crops, and when these are of the same or nearly the same kinds the increase in the pests may be enormous. If, however, a crop which is entirely unsuited to the pests is planted between two similar crops, they are starved out.

Ploughing, forking and hoeing are useful agricultural practices as preventive measures, because they expose a large number of insects to attacks of natural enemies.

Cultivations of tree crops should receive the same consideration in the application of preventive measures as field crops. Prunings and dead wood of all kinds should be gathered and burned, or buried deeply enough to prevent the emergence of any insects which they may contain, and also to prevent adult insects from gaining access to them for the purpose of egg-laying.

In dealing with the pests which attack man, the greatest importance attaches to preventive measures. Mosquitoes breed in stagnant water which may be accumulated in swamps, ponds, pools, old tins, bottles, etc., in cisterns and water tanks, and even in hollows in plants, or in the sheathing bases of leaves of such plants as the wild pines. The removal of these breeding places, or the treatment of them to make them unsuitable for the purpose, and the destruction of the mosquito larvae by the use of kerosene, will have the effect of preventing mosquitoes from becoming numerous. Cisterns and tanks may be enclosed with wire mesh, and they may be stocked with the fish known as millions. Millions are also useful in ponds and swampy situations.

House-flies may be kept in check by the proper treatment of manure and all decaying organic matter which would furnish a breeding place for these pests. The occurrence of fleas and bed-bugs in numbers can be prevented by the adoption of the necessary precautions and cleanliness.

With regard to the occurrence of the insect and mite pests of domestic animals, the same rules in reference to precautions and cleanliness hold good.

Household pests may also be controlled to a large extent by similar means

All food materials should be kept from these insects, as far as possible; repellent substances should be freely used, and the utmost regard paid to cleanliness.

LEGISLATION AND IMPORTED PLANTS. Many insects which have developed into pests of first importance have done so in countries or localities into which they have been introduced. The admission of such pests has generally been in connexion with imported plants. The insects most liable to be brought in by this means are probably scale insects and white fly; but many others have been known to be introduced in this way. Insects which live as borers, or within the tissues of plants in any way, may easily be transported and become established under new conditions. Grain and seeds also easily harbour insects, and provide for their introduction to new localities.

In order to provide against the introduction of insect pests in this way, legislation has been enacted in all the West Indian islands, making it possible for the Governor of each Colony to prescribe the conditions under which plant material of all kinds intended for propagation may be imported. The total prohibition of the importation of all such plant material from any country where diseases and pests are known to occur, which it may be deemed impossible to destroy on imported plants, may be ordered; while it is provided that all plant material intended for propagation shall be disinfected in such manner as the officer responsible for this work shall decide to be the most suitable.

Fumigation with hydrocyanic acid gas and carbon bisulphide, and disinfection by means of Bordeaux mixture, are the methods most frequently prescribed. In Barbados, cotton seed imported for the manufacture of cotton seed oil is fumigated with sulphur dioxide.

Remedial Measures.

INSECTICIDES. These may be divided into four general groups: stomach poisons, contact poisons, fumigants and repellents.

Stomach poisons are those substances which are used in such a manner that they will be eaten by the insect, and taken into the digestive system. It will be seen that such poisons are useful only in the case of insects which bite off, and swallow, particles of food to which poison may be applied or of those which, having sucking mouth parts, will take an artificial food to which a stomach poison has been added.

Contact poisons are useful against all soft-bodied insects which can be reached by an application of substances that may come into contact with their bodies. It is obvious that insects which feed by puncturing the tissues of plants and sucking food from the juices within cannot be killed by the application of a stomach poison on the surface of the plant. Contact poisons are especially valuable in dealing with insects having this habit of feeding. Soft-bodied insects, such as some caterpillars and slugs, may also be killed by contact poisons, when this method is more convenient than the use of the stomach poisons.

Fumigants are useful for dealing with insects which cannot be reached by stomach poisons or contact poisons, or live under such conditions that it is possible to surround them with a poisonous vapour. Insects of various feeding habits may be controlled by the use of this kind of insecticide.

Repellents are often useful in situations where the other insecticides are not applicable, or in dealing with insects which are with difficulty reached by the other kinds of insecticides.

As a preliminary to the consideration of the substances used for the destruction of insects, it may be useful to review the structure of the mouth parts of these animals and the manner in which they obtain their food. In general, it may be said that insects possess mouth parts adapted for sucking or for biting.

The jaws of insects are placed at the sides of the mouth and have a lateral motion. Strong mandibles are provided for the purpose of biting off particles of food, while the maxillae aid in chewing and in conveying it to the gullet. This is the normal condition, which is found in such insects as the cockroach, grasshopper, beetles, both larva and adult, and the caterpillars of butterflies and moths.

Insects which obtain their food by sucking it up in a fluid form possess mouth parts which are modified for the purpose. The mandibles or the maxillae, or both, are arranged so as to form some kind of proboscis in which is combined the ability to pierce the tissues of plants or animals and to suck up the juices which are reached in this way. Mouth parts of this description are to be found in plant bugs, aphids, scale insects and white fly attacking plants; and in ticks, lice, fleas and bed-bugs, which attack animals.

Flies and bees combine an ability for biting and for lapping or sucking in the same individual; while butterflies and moths are often able to suck up the sweet juices exposed in the nectaries of flowers, without possessing the ability to pierce any but delicate tissues.

Thrips have remarkable mouth parts, in that one of the mandibles is well developed, while the other is much reduced in size. The well-developed mandible is probably used for cutting or lacerating the surface of plant tissue; while the modified maxillae form a lapping organ, by means of which the soft tissues underlying the surface may be utilized for food.

The larvae of the lace-wing flies have biting mouth parts, but modified in a peculiar manner. The mandibles are well developed, and grooved. The small insects on which these larvae feed are captured and held by the mandibles, while the body juices are sucked out by means of the grooves.

As far as the structure of the mouth parts has relation to the use of insecticides, it is sufficient to classify them as biting and sucking mouth parts. A knowledge of the great modifications which have been brought about by the adaptation to different foods and different modes of life, will perhaps help readers of this book to realize the necessity of exercising some thought in preparing to deal with insect pests.

STOMACH POISONS. The principal stomach poisons are those derived from mineral sources, and chief of these are arsenic and its several compounds. The arsenical insecticides are useful in combating nearly all insects with biting mouth parts, and may be applied to a great variety of plants. Leguminous plants (peas, beans, etc.) and the Cucurbitaceae (melon, cucumbers, etc.) often suffer severe injury when sprayed or dusted with this class of poison, and trials should be made on a small scale before treating large areas of these crops, in order to determine the correct strength of the application under the existing local conditions.

Paris green. Paris green depends largely for its effectiveness on the amount of arsenic which it contains, the arsenic being united with copper which is also combined with acetic acid. A good quality of Paris green should contain not less than 56 per cent. of arsenic, of which only about 5 per cent. should be soluble in water.

The soluble arsenic in Paris green, or in any arsenical insecticide, is liable to injure the foliage of the plants to which it is applied; and it has been found that when the percentage of this is more than the proportion already mentioned considerable injury to plants is likely to result.

Paris green may be used either as a spray in a mixture with water, or dry. When applied dry it may be employed by itself or mixed with lime or any other dry fine powder. If it is used as a spray, the Paris green mixture should be applied by means of a very fine nozzle attached to a fairly strong force pump. When used dry, it should be very evenly distributed over the surface of the plant in such a way that all parts are reached by it, and at the same time, so that there is no thick layer of this substance on any part of the plant. It has been found in practice, in the West Indies, that Paris green is best applied as a dry mixture with finely pulverized air-slaked lime, the mixture being at the rate of 1 lb. of Paris green to 5 or 6 lb. of lime. The same proportion will be maintained if the mixture is made by using one part in bulk of Paris green to ten or twelve parts of dry air-slaked lime.

Several mechanical devices are available for the application of dry Paris green, some of which will be found under the heading of The Application of Insecticides. For use in cotton fields, and in connexion with similar low-growing crops in the West Indies, it has been found that cloth bags of fairly fine mesh are very satisfactory for the distribution of Paris green.

Paris green is useful in combating a great variety of insects which have biting mouth parts. It has been most used in the West Indies in dealing with the cotton worm; but in other parts of the world it has been employed against nearly all kinds of leaf-eating caterpillars, grasshoppers and cut worms.

Paris green is used as follows :—

As a spray. 1 lb. to 150 to 200 gallons of water. Mix the Paris green to a paste in a small amount of water before making up to the full quantity. Add 2 lb. of freshly slaked lime to each pound of Paris green. Apply by means of a force pump, using a nozzle which gives a very fine spray.

As a dust or powder. Mix Paris green and dry air-slaked lime in the proportion of 1 lb. of the former to 5 or 6 lb.

of the latter. Apply by means of a powder gun, bellows or cloth bag, in such a way that the mixture shall be evenly distributed over the plants to be treated.

London purple. London purple is also an arsenical stomach poison, and is a compound of arsenic and lime, containing a certain amount of colouring matter. The percentage of arsenic is smaller than that in Paris green, while a larger proportion of the arsenic present is likely to be soluble. It will be seen from this, that while London purple may be used in a manner exactly similar to that for Paris green, it ought always to be cheaper than this insecticide. It should be remembered, also, that the greater solubility of the arsenic in London purple requires that it should be used more carefully than Paris green, on account of the greater danger of injuring the foliage of plants.

The directions for using Paris green apply to London purple, both in the form of a spray and a dust.

Arsenate of lead. This is also an arsenical stomach poison. It is usually sold as a paste, and in this form can only be used as a spray in a mixture with water. Recently however, it has been put in the market in the form of a powder which, it is stated, can be used in the same manner as dry Paris green or London purple. The advantage attending the use of arsenate of lead results from its great degree of insolubility, and consequently the large comparative safety attending its application to plants A disadvantage which has been experienced in the West Indies results from its slower action as a poison. On this account, it has not been received as favourably by planters as Paris Green and London purple.

When used as a spray, 2 or 3 lb. of arsenate of lead in 50 gallons of water will be found satisfactory for the control of most caterpillars. The strength of the mixture may be increased, however, with very little danger of injuring the foliage of the plants.

The dry form of arsenate of lead may be used without being mixed with lime, as on account of its white colour it can easily be seen on plants treated.

White arsenic. This is a stomach poison, but it is not adapted to general use. Its greater degree of solubility makes it less satisfactory to apply to the foliage of plants, since on account of the possession of this property it is liable to cause burning or scorching.

This poison finds its principal use as an insecticide in the preparation of poison baits for such insects as grasshoppers, termites, cut worms, beetle grubs and crickets.

For use against cut worms, as a poison bait, mix 1 lb. arsenic with 25 lb. bran or pollard, and stir to a thick mash with water to which molasses or sugar has been added to impart a sweet taste. A tablespoonful in each hole at the time of planting cotton or other seed will be found sufficient to kill practically all the cut worms.

For use against grasshoppers, take half-barrel of fresh (or moist) horse droppings, 1 lb. salt and 1 lb. arsenic, and thoroughly mix. Paris green or London purple may be used instead of the arsenic. This mixture, put down freely in small heaps containing a half-pint or less, in any field or infested pasture, should give good results.

For use against termites, when these appear in buildings, a mixture of arsenic and sugar in the proportion of one of arsenic to two or three of sugar will be found useful in checking the increase of these pests. The covered gallery of these insects should be broken away for an inch or two, and the poison put down on the broken portions. The poison will be eaten by a few ants, and these by others, so that a small amount of poison thus applied will be distributed through the nest or colony.

Arsenic also has an action as a contact poison and forms one of the constituents of certain cattle dips and washes for the destruction of ticks.

Corrosive sublimate. This is a very powerful poison and it is not used for general insecticidal purposes. It has a very injurious effect on the foliage of plants, and its extremely poisonous nature makes it a dangerous substance to put into the hands of ordinary labourers. It is useful for the purposes of disinfection, since it has a fungicidal action. It is employed in the preparation of book solution, which is used to protect the bindings of books from the feeding of cockroaches, silver-fish and to some extent from that of the book worms, which are the larvae of the cigarette or the drug store beetle. Book solution is composed of the following materials:—

Corrosive sublimate	1 oz
Carbolic acid	1 oz.
Methylated spirits	1 quart

This mixture, applied to the binding of books by means of a fine brush, is an excellent protection. The carbolic

acid and the corrosive sublimate are, on the evaporation of the spirit, left as a very fine covering of poison on the entire treated surface. The poisoning has to be repeated from time to time, according to climate and the abundance of insects. Books thus treated are quite safe to handle.

Corrosive sublimate, used for disinfecting seed for planting, protects it from subsequent insect attack by means of the fine deposit of poison on the surface of each seed.

Corrosive sublimate also has a strong effect as a repellent for ants. The legs of a table or safe washed with any solution or mixture of this poison are quite safe from attacks as long as the poison remains. Ants apparently will not cross any surface treated with corrosive sublimate.

Boric or boracic acid. This is a specific as an insecticide for cockroaches. Although not a poison in the ordinary way, this substance seems to have a particularly deadly effect on these insects, and it is of course especially valuable for use in dwelling houses, since cats, dogs, fowls and even human beings are not injuriously affected by it if it should be eaten by them.

Equal parts of boracic acid and sweet chocolate, flour, molasses or sugar, put down in places frequented by cockroaches, will be effective in reducing their numbers. When one mixture has been used for a short time, a change to another of those suggested will be found of advantage.

Phosphorus. This substance is often used in the preparation of rat poison and in poison, for crabs. Rat poison containing phosphorus is eaten to some extent by cockroaches, apparently with effect.

The insecticides mentioned already are mineral poisons. Several vegetable substances are useful as insecticides, the chief of which are pyrethrum, tobacco and hellebore. Vegetable insecticides lose their power when exposed to the air for any time, and on account of this tendency, are likely to deteriorate in the tropics. Pyrethrum is composed of the finely ground dried flower heads of a plant of the Chrysanthemum group *Pyrethrum roseum.* Pyrethrum, Dalmatian and Persian insect powder, and Buhach are names given to this, and to other products from closely related plants.

Pyrethrum. This is a very useful insecticide, possessing qualities both as a stomach and a contact poison. When fresh and of full strength it is a bright yellowish powder with a pungent ordour, rather pleasant than otherwise. In the tropics it finds its greatest usefulness in connexion with fleas, lice and bed-bugs. Applied dry to the coats of dogs and cats, and to the plumage of fowls, it very quickly drives out fleas and lice, killing many of them.

Travellers in the tropics would do well always to carry a supply of pyrethrum. A little scattered between the sheets in hotel beds may ensure a good night's rest, which otherwise might be impossible. For use on house plants, pyrethrum is of great valne. An ounce of this substance placed in one quart of hot water and then diluted to make one gallon, forms an excellent spray or wash for killing caterpillars and other small soft-bodied insects. A mixture of pyrethrum with twice its bulk of flour makes an excellent insecticide, the flour absorbing a certain porportion of the poisonous quality, and all parts of the mixture becoming equally effective.

Pyrethrum, burned in a room which can be closed, will stupify all mosquitoes and flies, and they can be swept up from the floor and destroyed; if left to them. selves, however, they will recover. For this purpose 3 ℔ to each 1,000 cubic feet is the amount to be used.

Tobacco. Tobacco has a wide range of usefulness as an insecticide, and when the stems, broken leaves, dust, etc., are easily obtainable they may be put to a variety of uses both as a contact insecticide and as a repellent.

At the present time, there are several excellent preparations on the market which are prepared from tobacco, but these are probably not to be obtained in the West Indies, Tobacco dust, applied dry, has much the same uses as pyrethrum, and in a decoction also it is useful in the same way, while it is even more so as an application to the soil for the destruction of grubs, worms, and small pests about the roots of plants. Tobacco dust and stems applied to the surface of the soil about cabbage, melons, cucumbers and many ornamental plants will often serve to keep off injurious pests.

Tobacco stems are useful in the nests of sitting or laying hens, as a remedy for poultry lice.

Hellebore. Hellebore consists of the finely ground roots of *Veratrum album*, a plant of the order Liliaceae. It is used in temperate climates for the control of soft-bodied slugs and caterpillars, on certain plants, but will probably have only a limited application in the tropics. Its properties are similar to those of the vegetable poisons already mentioned, but it is not as strong in its effect.

CONTACT POISONS. Contact poisons are generally more difficult in preparation for use than the majority of stomach poisons, since most of them are mixtures of several substances, which require care in their preparation.

The effect of contact insecticides is to cause the death of insects by clogging or closing the breathing openings, (stigmata), by penetrating the stigmata and breathing tubes and thus causing a fatal irritation, or by forming a thin coating on the entire insect and sealing it down to the leaf or bark on which it occurs.

It will easily be seen, then, that for these to be effective, the insecticide must be brought into contact with the insect, careful application of the spray, wash or dust being most essential to successful results.

The materials which are most likely to be found useful as contact insecticides, either alone or in combination, are the following: whale-oil soap, fish oil, rosin, soda, soap, kerosene, sulphur, and lime; while pyrethrum, tobacco, hellebore, turpentine and hot water are all to be included among the insecticides of this group.

Whale-oil Soap. This is a very useful insecticide, especially for plant lice, leaf-hoppers, thrips, mealy-bug, white fly, and certain scale insects. It is also useful for treating insects at the base of plants, in pots or garden beds, and it may be used with good results on caterpillars and other soft-bodied insects which feed in exposed situations. It has the advantage of being easily prepared for use, and the disadvantage, or what is considered to be so by many, of being very foul-smelling.

It is used in solution, in varying strengths. Palms and other plants with tough leaves will suffer no injury from the application of the stronger mixtures, while for tender-leaved plants the strength may be much reduced.

Whale-oil soap is prepared for use by merely being dissolved in water, the proportions being from 1 ℔. in 2 gallons to 1 ℔. in 8 gallons, of water.

Rosin. The spray mixtures containing rosin are useful in combating the unarmoured scales (Saissetia, Coccus), and other scale insects and thrips; but is of most value in dry seasons and when the young scales are most abundant. Rosin is applied in combination with other materials as a spray or wash.

Rosin compound is made of:—

Powdered rosin	4 lb.
Powdered washing soda	3 lb.

This quantity is sufficient to make 30 gallons of wash. It is prepared by mixing the constituents thoroughly, and dissolving by boiling, in 1 gallon of water, in a vessel with a capacity of at least 5 gallons. Water is slowly added to make 5 gallons, the mixture being kept boiling. This is the stock solution; when cold it should be of a clear brown colour. For use, add 5 parts of water to 1 of the stock solution.

Rosin wash is similar to the preceding, but contains an oil, which gives it a more penetrating effect.

Rosin wash is thus constituted:—

Powdered rosin	20 lb.
Caustic soda	3½ lb., powdered fine.
Fish oil	3 pints, which will be sufficient to make 100 gallons of wash.

Mix these materials, and cover with about 2 inches of water, and boil. When the liquid is clear, add water slowly, still boiling the mixture, until the whole is made up to 15 gallons. This is the stock solution, sufficient to make 100 gallons of wash. In diluting this, only rain-water or soft water should be used.

Rosin and Whale-oil Soap Compound. This is a still more general insecticide. It consists of:—

Powdered washing soda	3 lb.
Powdered rosin	4 lb.
Whale-oil soap	10 lb.

To obtain it, boil the soda and rosin in 1 gallon of water until they are dissolved, then make up slowly to 5 gallons, still boiling the mixture. In another vessel, dissolve 10 lb. of whale-oil soap in 5 gallons of water, by boiling. The stock solution is made by mixing these two solutions. This is sufficient to provide 45 gallons of wash.

Kerosene Emulsion. This is one of the most useful of all the contact insecticides, for spraying plants against scale insects, mealy-bug and all related insects. The difficulty of getting a true emulsion with the water which is available in many localities has proved an objection to its use, but with care and by the use of rain-water, an emulsion ought to be obtained. Kerosene emulsion is made from :—

Hard soap	½-lb.
Kerosene	2 gallons

Dissolve the soap in 1 gallon of water, by boiling. Remove from the fire and immediately add 2 gallons of kerosene, and churn violently with a syringe or force pump until the mixture becomes creamy, and the oil is all held by the soap. This is the stock solution, and is sufficient for 33 gallons of wash. Great care should be taken to get a perfect emulsion, as any free oil is likely to injure the plants. If any considerable layer of oil is observed on the surface of the stock solution when it has stood for 24 hours or more, the emulsion is not perfect. If difficulty is experienced in this respect, an increase of the amount of soap will often aid in producing the emulsion.

Kerosene Emulsion, with soft soap. This is similar to the preceding both in its action and in its use. It is made from :—

Soft soap	1 quart
Kerosene	1 pint

To prepare it, dissolve the soap in two quarts of hot water and add the kerosene, making the emulsion in the manner described above. This is the stock solution and is made ready for use by adding an equal amount of water.

Kerosene. In addition to its application in kerosene emulsion, this oil may be made to form a valuable insecticide in other ways. It may be used in a mechanical mixture with water, by means of a special pump, as a spray for scale and other insects, and when used by itself produces excellent results in special cases.

Mosquito larvae, in tanks, water barrels, and similar situations where it is not desirable to introduce fish, may be destroyed by an application of kerosene to the surface of the water. The larvae are killed by the kerosene when they come to the surface to breathe, the oil penetrating the breathing spiracle and causing death.

Household insects such as bed-bugs, ants in floors and termites in woodwork may be destroyed by the free use of kerosene, and many flying insects which are attracted may be caught in a tray of water and kerosene over which a light is suspended. The insects, flying to the light, fall into the tray below, where they are killed by the film of kerosene on the water.

Tobacco and Soap. Tobacco and soap is often a convenient mixture, especially for house plants, where the smell of whale-oil soap would be an objection to employing that substance. It is composed of :—

Soft soap	1 quart	or
Hard soap	½-lb.	
Tobacco refuse	½ lb.	

Dissolve the soap in 5 gallons of water, steep the tobacco in 2 quarts of water for 24 hours, strain and add to the soap solution. This mixture is used without further dilution.

Crude Oil and Whale-oil Soap. This mixture has a wide range of application and possesses the valuable quality of keeping well. It is sold in Barbados under the name of Lefroy's mixture, Mr. Lefroy being the originator of the compound.

Whale-oil soap	10 lb.
Crude Barbados oil	5½ pints
Naphthalene	4 oz.

Heat the soap in a metal vessel. Dissolve the naphthalene in the oil by stirring. Add this mixture to the hot soap, away from the fire, and thoroughly mix the whole by stirring. A nearly solid soap-like substance is produced which is prepared for use by rubbing up or stirring it in water. Use at the rate of 1 lb. to 3 lb. in 10 gallons of water.

Sulphur. Sulphur may be used either dry or as a spray. When used dry, it may be applied by itself or in a mixture with varying amounts of lime. When used as a spray, 1 lb. in from 2 to 4 gallons of water is a convenient strength. Sulphur has a special value in combating mites of all sorts, including ticks, poultry mites, red spider, leaf-blister mite and the orange rust mite. It is also a constituent of many ointments, applied in the case of mange, itch and similar affections, which are due to the presence of mites.

When used for the control of ticks on animals, sulphur is best combined with oils as is suggested on p. 131 Sulphur and lard well mixed and used on setting hens will prove effective in preventing the attacks of mites and lice. Sulphur and air-slaked lime, in equal parts, dusted on the leaves of plants controls plant-feeding mites, red spider and thrips.

Sulphur dioxide, made by burning sulphur, is useful for fumigating buildings, holds of ships and similar places, for the destruction of mosquitoes and of insects in grain and seed; but the tarnishing effect of the gas on metals requires that care be exercised in using this substance in houses. Seeds for planting should not be fumigated with sulphur dioxide, as their germinating power is injured, and often in fact completely destroyed, by this process.

Carbon Bisulphide. This is one of the most useful insecticides for fumigating purposes, as it possesses a very wide range of application, and is very effective in the destruction of insects.

Carbon bisulphide is a liquid slightly heavier than water, which volatilizes rapidly at ordinary temperatures. Its fumes are much heavier than air, and have a very considerable power of penetration. They are inflammable and slightly poisonous to man, so that care must be exercised when this insecticide is being used.

Carbon bisulphide can only be used successfully when the fumes can be confined in a receptacle which is practically air-tight. It is especially valuable for the destruction of insects attacking stored products of all kinds, such as grain, flour, household stores and drugs, books, music, papers, clothing and all similar materials. Granaries, store-rooms and dwelling houses may also be fumigated for the destruction of insects, while it is effective for dealing with ants and grubs in the soil.

Grain, seeds, flour, books and clothing can be treated in tight boxes, casks or hogsheads. The amount to be used is calculated in large enclosures at the rate of 1 lb. per 1000 cubic feet of space; for grain in bins, 1 lb. per 100 bushels. For dealing with smaller capacities the amount to be used is 1 drachm, or roughly a teaspoonful, to each cubic foot of enclosed space. This can be easily calculated

for any rectangular box, and if the following doses be taken as correct, barrels, casks and hogsheads may be used to good advantage.

For fumigating with carbon bisulphide in a

Hogshead	use 5 oz. of the liquid
Cask or puncheon	„ 2 oz. „ „ „
Barrel	„ 1 oz. „ „ „

In using carbon bisulphide, it must be remembered that the fumes are very inflammable, and no fire, pipe, cigar or other light should be brought near on account of the danger of an explosion. The fumes are also heavier than air, and consequently, the liquid to be evaporated should be exposed, in a shallow dish, at the top of the room, box or other container. The carbon bisulphide will evaporate, and the gas descend and penetrate through all the interstices.

If a wooden box with a cover is used as a fumigating chamber, a hole in the cover, with a wad of absorbent cotton attached below, will provide for the introduction and evaporation of the insecticide, the hole being closed with a cork. A blanket or tarpaulin serves well for a cover to a barrel or hogshead, and a saucer or similar dish will answer the purpose of a receptacle and evaporator.

The evil smell of this insecticide will quickly disappear when the fumigated articles are exposed to a free circulation of air.

Ants in lawns or in garden beds may be killed by the use of carbon bisulphide, by merely pouring into the principal entrance to the nest 2 or 3 oz. of the liquid, and closing it with soil. All other entrances and exits should be closed, and the fumes penetrating to the deepest recesses and through all the galleries will completely kill out the nest Nematodes and grubs may be treated in a similar manner.

Carbon bisulphide has a limited application as a garden insecticide for the destruction of plant lice and similar insects on low-growing plants. A box of 2 or 3 cubic feet capacity makes a convenient fumigating chamber when placed over an infested plant. A hole in the top of the box will serve for the introduction of the insecticide, while a wad of absorbent cotton on the inside of the box under the hole will serve as a receptacle and evaporator. The hole can be plugged with a cork,

Cyanide of Potash or Potassium Cyanide. This insecticide can be obtained by mixing potash with prussic acid. It is an extremely poisonous substance, which has in recent years come into great prominence in connexion with the fumigation of living plants infested with scale insects In many parts of the world fruit trees are fumigated regularly for the control of insect pests, the trees being covered for the purpose by means of tents of air-tight canvas to confine the gas made from the potassium cyanide in proximity to the parts of the tree.

In the West Indies, fumigation of trees has not become a regular practice, chiefly on account of the expense of the process, which is very large in proportion to the value of the products of the trees.

Imported plants are fumigated, according to law, before being allowed entry to any colony for the prevention of the introduction of insect pests.

In using potassium cyanide for fumigating purposes, hydrocyanic acid gas is produced by the action of sulphuric acid and water on it, in the following proportions :—

Potassium cyanide	1 oz.
Sulphuric acid	1½ oz.
Water	2¼ oz.

These amounts are suitable for an enclosed space of 300 cubic feet.

Potassium cyanide can be used with good results for treating many of the insects for which carbon bisulphide has been suggested. The very poisonous nature of this insecticide must be borne in mind, however, and only responsible persons allowed to handle it.

It is probable that food stuffs would not be injured or rendered poisonous by being fumigated with potassium cyanide, but many persons would very likely prefer not to take the risk.

Books, clothing, and grain, however, might safely be treated with this material, if this is desired.

Ants may be killed by pouring into the nest a solution made by dissolving ½-oz. of potassium cyanide in 2 quarts of water. The dissolved poison penetrates the soil, and gives off fumes which kill the insects.

Camphor. Camphor as a repellent, and to some extent as a fumigant, has a value as an insecticide. Placed in trunks, boxes and wardrobes, it has a tendency to keep out moths, cockroaches and similar insects. It is useful also for keeping the nests of fowls free from parasites.

As a fumigant, camphor in equal parts with carbolic acid, is excellent for killing mosquitoes in the rooms of dwelling houses. Four ounces of this mixture for each 1,000 cubic feet of space in the room, vaporized by being placed over a gentle heat, will kill all the mosquitoes if the room is tightly closed for two hours. This is one of the best fumigants for this purpose; the fumes are practically harmless, possess excellent disinfecting qualities, and leave in the room a pleasant, refreshing odour.

Naphthalene. This is sold in the form of flakes and crystals, and in moth balls, and in both forms is well known for its characteristic odour which has the property of repelling insects. Used in the manner suggested for camphor for protecting clothing, books, etc., in boxes and trunks, it is both cheap and effective. A very strong atmosphere containing naphthalene is fatal to many insects.

The flakes seem to be more effective than the moth balls, no doubt because the former volatilize more rapidly, and partly perhaps because they can be more thoroughly distributed throughout the materials to be protected.

Some persons object to the odour of naphthalene, but in many cases this is largely due to their not being sufficiently familiar with it, and at the same time their not realizing the very considerable usefulness of this insecticide in the protection it gives from tropical insects.

Naphthalene is one of the constituent parts of Paranaph, an insecticide originated by the Jamaica Department of Agriculture, which is said to be of value as a contact poison for the destruction of fleas, ticks, plant lice, and certain scale insects.

Alum. Alum is said to repel or to destroy fleas when dusted on the floor of an infested room, and when used for that purpose, to prevent the occurrence in beds of these

insects and of bed-bugs. An old sheet soaked in a fairly strong solution of alum in water and then wrung out and dried, retains a sufficient amount of alum so that when it is spread over the mattress and under the sleeping sheet it keeps away these undesirable insects.

Creasote and Carbolic Acid. These are satisfactory repellents when used for certain purposes. Creasote, applied to wood and timber, prevents the attacks of termites for a time, and carbolic acid, added to lime wash, is said to increase its effectiveness when applied to the trunks of trees to prevent the entrance of boring insects. Mixed with lime at the rate of 1 pint of the crude acid to every 100 lb. of the lime, it forms a repellent which, dusted on the leaves of certain plants protects them from the attacks of insects. This method may be employed against weevils and certain other beetles which are not easily killed by Paris green. The best way to prepare this material is to slake to dryness temper lime with water to which the carbolic acid has been added.

Carbolic acid is also useful for treating wounds infested with screw worm, since it cleanses and disinfects them, and kills the maggots.

Air-slaked Lime. This is sometimes employed as a repellent, with good results. When it is mixed with Paris green or other arsenical poisons, its effect is that of combining with the free arsenic and thus reducing the amount of burning of the foliage; it also indicates plainly where the poison has been applied.

Aromatic Oils. Mosquitoes, gnats, sand flies and similar insects, which annoy by their persistent attacks, may be kept away by smearing the hands and face with an aromatic oil. Citronella, lavender, bergamot and other oils are useful for this purpose. An excellent mosquito repellent may be made by mixing equal parts of sweet oil and oil of citronella.

Turpentine. Turpentine has a limited application as an insecticide. Applied to infested beds it kills bed-bugs, in the egg, larval and adult stages. For treating screw worm in wounds, it is also of value and is applied by means of a brush or swab in such a manner that the breathing openings of the larvae will be touched by the turpentine.

PRICE LIST OF INSECTICIDES IN BARBADOS, 1911.

Paris green	... ...	... per lb.	28-30 cents.
London purple	... ...	... „	24-30 „
Arsenate of lead	... ...	... „	24 „
White arsenic	... ...	... „	
Cyanide of potash	... ...	... „	72 „
Corrosive sublimate	...	... „	$ 1·44 „
Boracic acid	... ...	... „	40 „
Phosphorus	... ...	... „	$ 1·44 „
Carbon bisulphide in 1 lb. tins		... „	60 „
„ „ Fuma brand in 5gal. drums		„	15 „
Whale-oil soap	.. ...	... „	10-12 „
Hard soap	... ...	... „	6 „
Soft soap	... ...	... „	12-18 „
Fish oil	... ...	... per gal.	48 60 „
Rosin	... ...	... per lb.	5 „
Washing soda	... ...	... „	4 „
Caustic soda	... ...	... „	24 „
„ „ in 10 lb tins	...	... „	18 „
Carbolic acid (crude)	..	... „	24 „
Lime, air-slaked	... ...	... per bushel	6 „
Sulphur (flowers	... ...	... per lb.	6 „
Pyrethrum	.. ...	... „	72 „
Hellebore	... ...	.. „	34-48 „
Turpentine	... ...	.. per pint	18-24 „
Kerosene	... ...	... per gallon	15 „
Citronella (oil)	... ...	... per oz.	12 „
Lavender (oil)	... ...	... „	24 „
Bergamot (oil)	... ...	... „	24 „
Naphthalene, small quantities		... per lb.	24 „
„ in large quantities		.. „	12 „
Camphor	... ...	... per oz	10 „
Alum	... ...	... per lb.	10 „
„ in large quantities	...	... „	6 „

THE APPLICATION OF INSECTICIDES. Within the past few years, great progress has been made in the development of pumps, nozzles and other appliances for spraying plants, and there are also many devices for the dry application of insecticides.

Spraying apparatus ranges from elaborate power outfits to portable sprayers carried by one man, and syringes, atomizers and similar simple machines for the treatment of house and garden plants.

The essentials for spraying are the pump, the container, the hose and the nozzle. The pump should be strong and durable, and is generally best when the working parts are of brass. An agitator is also essential; this is generally attached to the pump. Most of the spray mixtures that are used require to be constantly stirred in order that the spray shall be of uniform quality during the entire operation of spraying. The nozzle is also of first importance. Its structure should be such as to produce a very fine spray, thrown with force from the aperture, and an extension consisting of a suitable length of gas pipe should be used to connect the nozzle with the hose, in order that the distance between the nozzle and surface being sprayed may be very short.

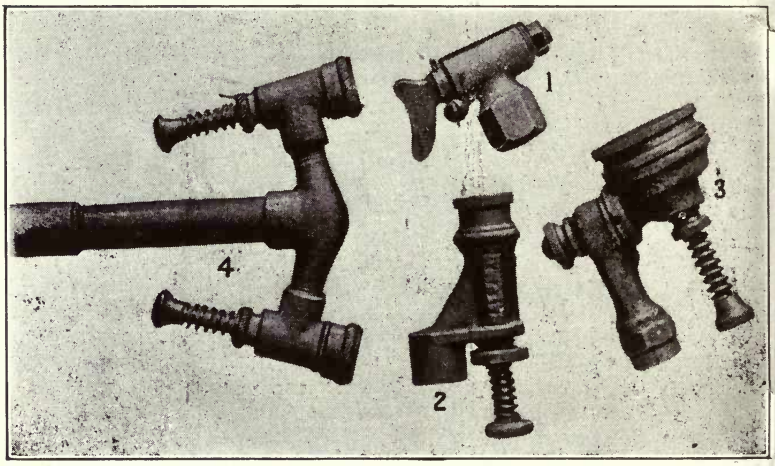

Fig. 169. Spray nozzles.
(*1*) *Bordeaux*; (*2*), (*3*) *and* (*4*) *varieties of Vemorel. Reduced.* (*Original.*)

The Vermorel nozzle is a form which produces such a fine spray. This is made in several different patterns, but the essential features are the same in all. The nozzles shown in Fig. 169, Nos. 2, 3, and 4 are patterns of this type. No. 4 being merely two nozzles fixed to a single feed pipe, Nozzles in groups of three or four are also manufactured.

The Vermorel nozzle is especially suited for spraying solutions, and mixtures containing no solid particles which

might cause clogging. A plunger surrounded by a spiral spring, shown in the illustration, is provided for clearing the nozzle if it becomes clogged.

The Bordeaux nozzle (Fig. 169, No. 1) is adapted for spraying Bordeaux mixture and other spray fluids which are not true solutions or that contain solid particles which would clog a nozzle like the Vermorel. The Bordeaux nozzle is adjustable, being capable of throwing a solid stream when it is necessary in order to apply the insecticide at some distance from the nozzle, and also of throwing a fairly fine spray.

In spraying for the control of scale and other sucking insects with soft bodies, the object to be aimed at is to get every part of the plant wet, but not sufficiently so to cause any dripping from the leaves or branches. Spraying with a stomach poison is for the purpose of applying the poison in such a way that, in order to obtain its food, the insect will have to eat the poison.

The success of spraying depends on the care and intelligence with which the operation is conducted.

Power Sprayers. These are not likely to be adopted for use in the West Indies, because of their very consider-

Fig. 170. Fruitall sprayer.
Side of barrel cut away to show pump and agitator.

able cost and large size; the latter renders them unsuitable for the large majority of estates, where the ground is rocky and uneven.

Barrel Sprayers. These are cheap and very efficient. There are many good styles of barrel spray pumps on the market, a good idea of which may be obtained from the accompanying figures. These outfits may be mounted on wheels, and in fairly level situations they can be handled easily. (Figs. 170 and 171.)

Fig. 171. Gem spraying outfit.

Certain of these pumps will easily supply two lines of hose, with one man to work the pump, while others are capable of supplying only one line.

The spraying gang will thus consist of either two or three men who move the outfit from place to place.

Knapsack Sprayers. The knapsack sprayers are more portable than the barrel sprayers, being adapted for use by one person to each outfit. The Success knapsack sprayer and other machines of the same kind consist of a tank with a capacity of about 5 gallons, with a small force pump attached. The outfit is carried slung on the back of the labourer, the spray fluid being discharged by the action of the pump. The operator works the pump and directs the spray.

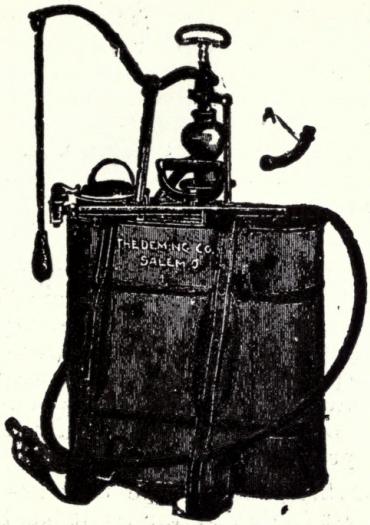

Fig. 172. Success Knapsack sprayer and bucket pump.

Another form of knapsack sprayer is the Auto Spray which consists of a tank of about 5 gallons capacity, with a pump attached. The object of the pump is to force air

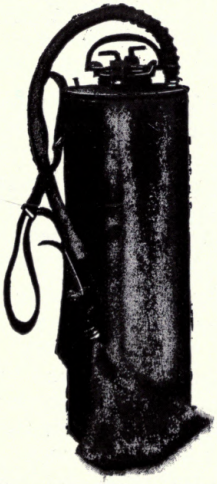

Fig. 173. Auto spray.

into the cylinder, which is air-tight. When a sufficient amount of pressure has been produced, the spray fluid is allowed to be forced out by the air pressure. In using this type of sprayer it is not necessary for the operator to pump and spray at the same time.

Bucket Sprayers. These are small pumps which are adapted for use in a bucket or other small vessel. They are very useful in applying a spray to a small number of plants, in a garden or conservatory.

Garden syringes and atomizers are hand sprayers adapted for treating small plants or a few of them. Their small cost and their adaptability to the requirements of persons having only a few plants to treat, make these instruments more popular than the more expensive ones, Many of them, however, get out of order easily if not used for a time, and others have the disadvantage of not throwing a fine spray.

A sprayer of this general type that has given satisfaction in the West Indies, as far as it has been tried, is called the Abol syringe; it is equipped with a drip preven-

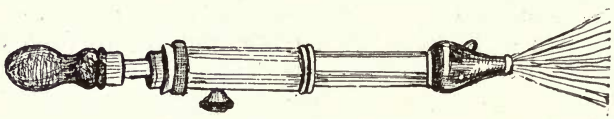

Fig. 174. Abol syringe.
Length slightly reduced. (Redrawn from advertisement.)

ter which saves the operator from becoming wetted with the drip running back down the syringe, and is provided with a good nozzle, which produces a very satisfactory spray, very similar to that formed by the Vermorel nozzle.

For the application of dry insecticides such as Paris green, lime and sulphur and similar substances, as a dust, the powder gun, the bellows, or the cloth bag are all of value for certain purposes, and such insecticides may also be applied direct from the hand in the manner of a sower sowing small seed broadcast. This last method should be generally employed in treating trees, such as the orange or lime, which are too tall to allow bags or a powder gun to be employed.

In the West Indies, by far the greater part of the stomach poisons are applied in a dry condition. The powder gun has been used to a small extent, but on account of its cost and the number of working parts planters do not care to put it into the hands of irresponsible labourers. In this form, the poison is contained in a receptacle, from which it is forced by an air-current generated by a revolving fan through a discharge tube, in a fine cloud of dust. The fan is operated by a wheel turned by the labourer.

The powder bellows is an instrument of the ordinary bellows type; in this is placed a suitable amount of insecticide, which is forced out as a cloud of dust by successive puffs. An inverted funnel attached to the outlet serves to spread the discharge. (Fig. 175.)

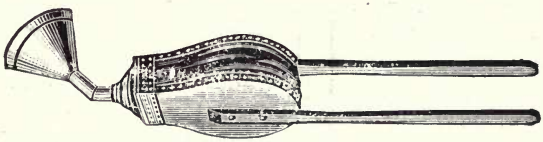

Fig. 175. Acme powder bellows.

The most generally employed method of distributing dry poisons in the West Indies is by means of the cloth bag.

Ticklingburg bags, of a suitable size held in the hand of the labourer have given every satisfaction in distributing Paris green and London purple, for combating the cotton worm. The bags are cheap, they cannot get out of order, and a very even application of the poison mixture can be made with them, a slight shake of the hand producing a fine cloud of dust which settles down on the plant. Tin shakers, consisting of a tin vessel with a perforated bottom have also been used in the same manner as the cloth bags. These do not generally distribute the poison in such a fine condition, with the result that a larger amount of insecticide is used.

CHAPTER X.

Insects and their Natural Enemies.

Insects, in the present age, may be said to be the dominant animals of the world. Not only do they greatly exceed all other classes of the animal kingdom in point of numbers of species, but many of these species occur in most amazing abundance.

Like all other living creatures, they form part of a complex scheme in nature made up of relationships between these forms. The relationship of insects to plants is generally that of an animal to its food; that is to say, insects for the most part are plant feeders, and when this relationship exists between an insect which occurs in considerable numbers, and plants which are of use to man, the insect is generally considered a pest. Some insects also procure their food by sucking the blood, or devouring the tissues, of animals. These may be parasitic or predaceous. Other insects, still, derive their sustenance from dead or decaying organic substances, and are known as scavengers.

Insects also serve as food for other insects, for birds, toads and lizards; these are called their natural enemies, and there are also certain forms of plant life which are able to attack and kill living insects, which are also to be included among their natural enemies. It will thus be seen that insects play a considerable part in the relationships which exist in the plan of nature. If it were not for the effect of natural enemies on insects, the world would in a short time become absolutely uninhabitable to any other forms of life, except perhaps the very lowest plants and animals, and the insects themselves would shortly die off, killed by starvation.

The natural enemies of insects may be considered under the following heads :—

(1) Insects { Parasitic. / Predaceous.
(2) Parasitic fungi
(3) Insectivorous birds.
(4) Toads, lizards, etc.
(5) Fish.

INSECTS AS NATURAL ENEMIES OF INSECTS.

Insects attack and destroy other insects in two ways. When it is natural for one insect to pass all or a part of its life-cycle within the body of another insect, or within its protective covering, as in that of scale insects, the first of these is called a parasite; while the other is called the host.

The insect parasites of insects are numerous and extremely useful in reducing the numbers of injurious species. They very largely belong to two orders, the Diptera and the Hymenoptera. The parasitic Hymenoptera form a large

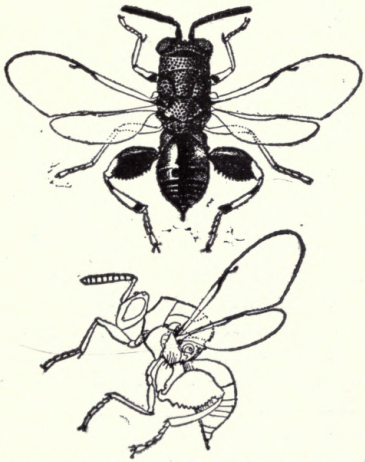

Fig. 176. One of the parasitic hymenoptera. *Enlarged.* (*From U.S. Dept. Agric.*)

group, and vary in size; many of them are very minute, some of them so small as to be scarcely visible to the unaided eye.

Not all parasitic insects, however, are to be considered beneficial from man's point of view, for certain of them

attack and destroy other parasitic insects. These are secondary or hyperparasitic, and they are often able greatly to lessen the good effects of the primary parasites.

In the second manner of attack, certain insects capture and devour bodily others, generally weaker and smaller than themselves. The insect which obtains its food in this manner is said to be predaceous in habit. Predaceous insects are to be found in nearly all orders, being perhaps

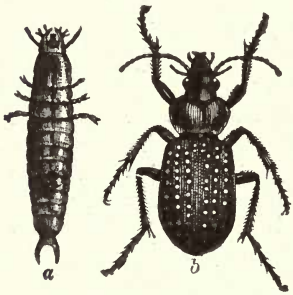

Fig. 177. Fiery ground beetle.
(*a*) *larva*; (*b*) *adult insect. Natural size.* (*From U. S. Dept. Agric.*)

most numerous among the Coleoptera, although pond flies, lace-wing flies, certain thrips, many Hymenoptera, many Hemiptera, some Diptera and Lepidoptera have this habit of procuring food. Among the Lepidoptera it sometimes happens when several caterpillars occur together as borers in a limited space. Among the Orthoptera the predaceous habit is found in the case of mole crickets, which devour small insects which come within their reach in their underground tunnels. Under certain conditions ants are of value as natural enemies of other insects, especially when the victims are out of their natural situation or are wounded and thus unable to escape or defend themselves. Insects which inhabit the soil are quickly attacked by ants if exposed on the surface, and this suggests the practice of ploughing or forking fields in which grubs and similar insects are pests.

PARASITIC FUNGI.

Parasitic fungi of several species are known as natural enemies of insects. Insects which are fixed in position for considerable portions of the life-cycle, such as scale insects and white fly, and those which have but little free-

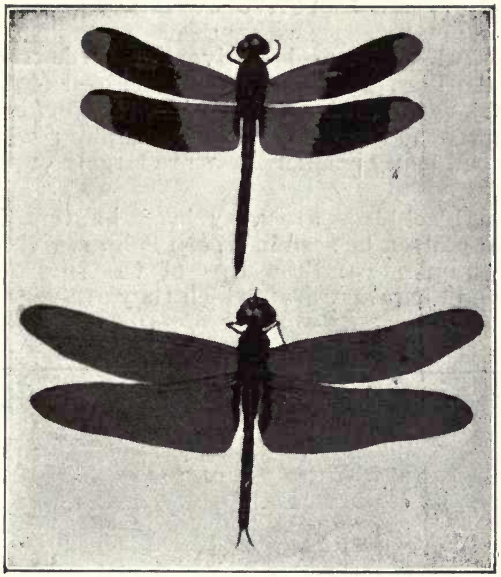

Fig. 178. Pond flies.
Enlarged. (Original.)

dom of movement, such as plant lice, mealy-bug and borers, are most subject to attack by fungi, although flies, cotton stainers, moths and grasshoppers are also affected, sometimes in such numbers as to materially influence the abundance of these insects.

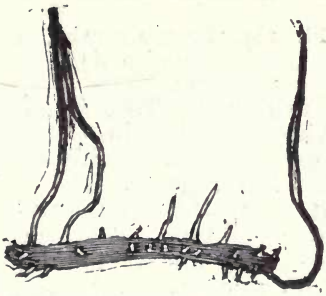

Fig. 179. **Moth borer larva attacked by Cordyceps Barberi.**
(Imperial Dept. Agric.)

Several species of insectivorous birds occur in the Lesser Antilles. The Barbados blackbird (*Quiscalus fortirostris*), the tick-bird or old witch (*Crotophaga ani*) and the loggerhead are conspicuous examples ; while certain hawks and many smaller birds are largely or partly insect feeders.

The blackbirds are very keen hunters for insects. They may often be seen in a corn field, searching the centres of the plants and the tips of the ears for the boll worm and corn ear worm, which they are very successful

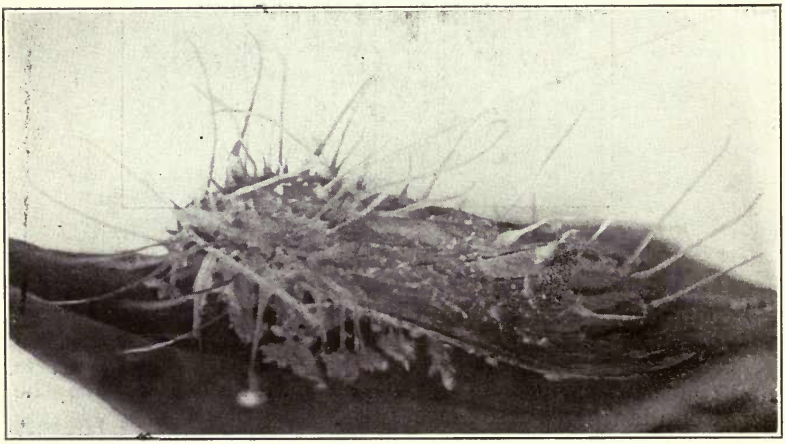

Fig. 180. Fungus growing on a moth.
(*Original*)

in finding and capturing. They also follow the plough, or labourers forking or hoeing in the field, inspecting the newly upturned earth and greedily devouring the insects and worms that are exposed. They may also often be seen picking ticks off cattle on the pasture, and this habit is shared by the tick-bird. The loggerhead is swift of flight and probably captures its prey in the air.

Turkeys, Guinea fowls and the common domestic fowl are all keen hunters for insects, which they capture and devour in large numbers.

TOADS AND LIZARDS.

Toads, called also crapaud or frog (*Bufo agua*) are largely insect feeders, and are very valuable in keeping down the numbers of many insects. They feed largely at night, and therefore capture many nocturnal insects but they also feed by day. Toads generally recognize their prey by its movements and consequently they rarely, if ever eat, dead or dying insects which may contain fungus or insect parasites. Toads have often been observed to watch an insect such as a cotton worm, lying motionless on the ground, for some time, and at the first movement of the insect to snap it up with lightning rapidity.

Lizards are largely insectivorous in their feeding habit. The ground lizards in certain islands, and the small green species which are to be seen on trees and plants, are always on the lookout for insects, and if one has the patience to watch for a few minutes they may be observed when stalking and capturing their prey. It is generally believed that in those islands where the mongoose has been introduced, the abundance of many insects is largely due to the fact that lizards, toads and many birds have been killed off by that animal.

FISH.

Many species of fish attack water insects and are specially useful in controlling mosquitoes. Millions, on account of their small size and greedy appetites, are particularly useful in the West Indies; but in all localities there are almost certain to be small fish possessing similar habits, which exert a considerable influence on the abundance of mosquito larvae.

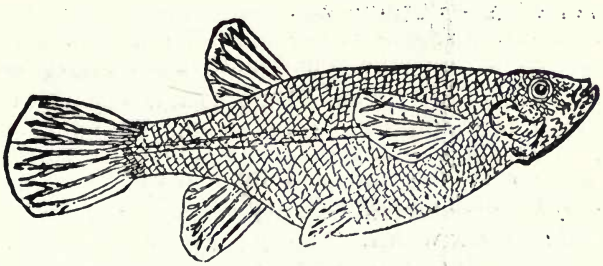

Fig. 181. Millions
Enlarged. (Imperial Dept. Agric.)

INSECTS WHICH ARE CONTROLLED BY NATURAL ENEMIES.

While all insects are controlled by natural enemies to a greater or less extent, a few instances may be given to show how this manner of control affects some of the most widely known of our West Indian pests.

THE MOTH BORER. The moth borer of the sugar-cane, although it is abundant every year in the West Indies, is probably controlled to a very considerable extent by natural enemies. During the time that the eggs of the moth borer are exposed on the leaf of the cane they are liable to attack by a very small hymenopterous insect. (Fig. 182.)

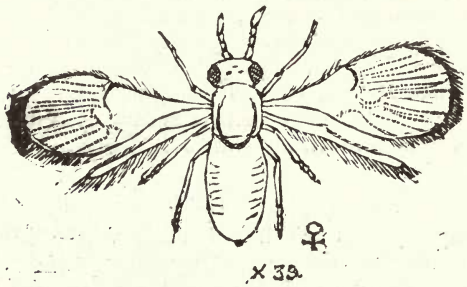

Fig. 182. **Hymenopterous parasite of eggs of moth borer.** *Greatly enlarged.* (*Imperial Dept. Agric.*)

The eggs of this insect are deposited in the eggs of the moth borer. The parasite grub hatches and begins to feed on the substance of the moth borer egg, and thus causes the death of the young moth borer caterpillar.

Probably many, if not all, moths and butterflies which lay their eggs unprotected in an exposed situation are subject to attacks of this kind by similar parasites. The moth borer is also attacked by a parasitic fungus (see Fig. 179) which destroys a certain number of the larvae.

THE COTTON WORM. The eggs of the cotton worm are attacked by an egg parasite, or perhaps more than one, in a manner similar to that already mentioned in the case of the moth borer. The cotton worm is also attacked by a

parasite which deposits its eggs within the body of the larva or pupa, where the parasite grubs feed and develop at the expense of the cotton worm.

The larger wasps, the cow bee, wild bee and Jack Spaniard are very important predaceous enemies of the cotton worm, in the West Indies. These insects build nests of paper; in these they deposit their eggs and the

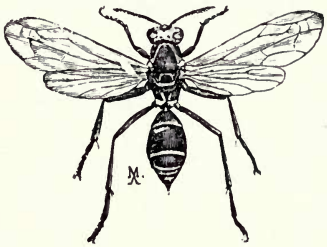

Fig. 183. Cow bee.
Enlarged. (From U.S. Dept. Agric.)

young are hatched and reared to maturity in them. The adult insects, of which there are generally several attached to each nest, go in search of food, which they bring to the helpless grubs. This food consists largely of caterpillars, and when the cotton worm is present in large numbers they are very much sought after by these insects.

The number of caterpillars caught during a season by wasps is very great, and it is considered in St. Vincent to be due to these insects that the cotton worm has not developed sufficiently to become a pest in that island.

It is likely also that many other leaf-eating caterpillars are controlled to a very large extent by these insects.

Cotton worms are also eaten by toads and birds; of the latter, perhaps the most useful is the blackbird.

The ground beetle is known to occur in St. Vincent and Barbuda, where it has been observed feeding on cotton caterpillars. It may occur in other islands, and probably would be a very useful check on these insects if it were present in sufficient numbers, since both the beetle and its grub are predaceous in habit.

SCALE INSECTS. Scale insects are attacked by the parasitic Hymenoptera, which have habits very similar to those of the egg parasite mentioned above. The eggs of the parasites are deposited within the body of the scale insect or under its protective covering, and the young grubs which hatch from these eggs feed upon the tissues of the body of the scale insect, or upon the eggs or young.

Only a few species of West Indian scale parasites are known; and the exact extent of their usefulness has not been determined, in the case of most of the scale insects, the amount of control which may be exerted by an insect of this kind is well illustrated in the case of the black scale of cotton, or the Hibiscus shield scale, as it is called.

The black scale of cotton was a very serious pest in Barbados, in 1905 and 1906. About that time its parasite began to develop very rapidly, and for the past two or three years the attacks of the parasite on the black scale have so completely checked its host that no serious outbreaks of black scale on cotton have been reported.

When scales are seen with small round holes in them it is a sure sign that the parasites have been present, have completed their life-cycle, and have emerged. It may be taken as a safe supposition that many other scales which do not have the holes in them are parasitized and that the holes will appear when the parasites are full-grown and make their escape.

Scale insects are also attacked by predaceous enemies—lady-birds, both in the larval and adult stages, attack the young crawling larvae of many species of scales. The larva of the lace-wing fly has a similar habit of feeding on the young of scale insects, and it is likely that these insects play an important part in the control of scale insects.

The caterpillar of a small moth feeds upon certain of the larger shield scales, and birds have been observed when they appeared to be eating scale insects. It is not likely, however, that these two last-mentioned natural enemies exert very much control over the abundance of scale insects.

Parasitic fungi are among the important natural enemies of scale insects in the West Indies. The red-headed fungus, the black fungus, and the shield scale fungus all have a wide distribution throughout the West Indies.

These fungi penetrate the bodies of scale insects and cause their death. The red-headed fungus may be recognized by the small orange-red fruiting bodies which are often to be seen attached to the purple scale of the orange and other species. The shield scale fungus forms a fringe of very delicate white growth which projects from under the bodies of the shield scales. (Fig. 185.) The black fungus may be most readily recognized by the small black patches which it forms in the midst of colonies of the white scales such as the orange snow scale.

These parasitic fungi exert a very considerable influence over the numbers of certain species of scale insects, but like most fungi, they make their best development in a considerable amount of moisture, and consequently their influence is greatest in damp localities and in the wet season of the year.

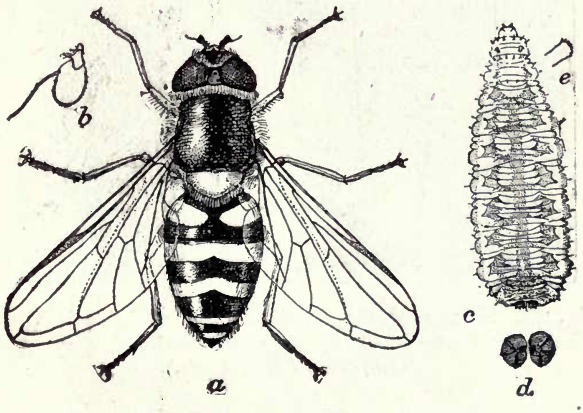

Fig. 184. Syrphus fly.
(a) fly; (b) lateral view of head; (c) larva. All much enlarged. (From U.S. Dept. Agric.)

PLANT LICE. Plant lice are attacked by the same kind of natural enemies as those that attack the scale insects, that is by predaceous insects and parasitic fungi. The predaceous insect enemies of plant lice include the lady-birds, the lace-wing and syrphus flies. They are also attacked by the parasitic Hymenoptera.

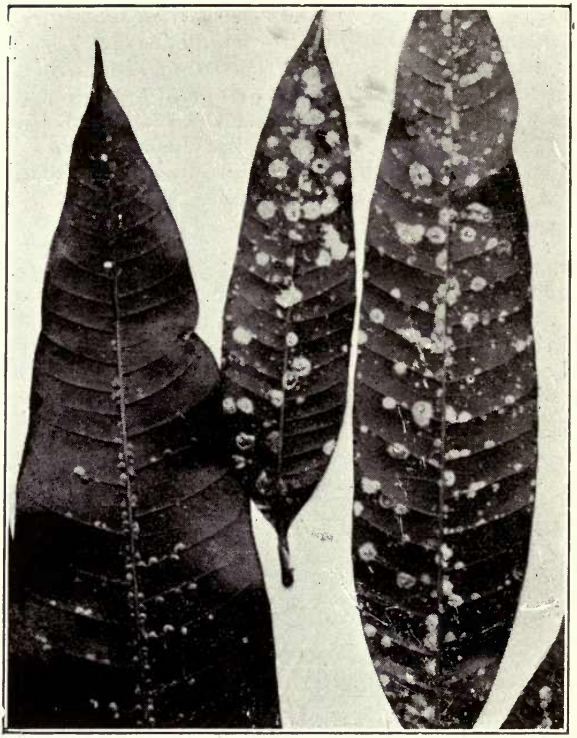

Fig. 185. Mango shield scale attacked by shield scale fungus. *Healthy scales on leaf at left, attacked scales on other leaves.* (*Imperial Dept. Agric.*)

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